ASSESSMENT OF WATER QUALITY IN THE PERIPHERAL RIVERS OF DHAKA CITY

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BY

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The project report "Assessment of Water Quality in the Peripheral Rivers of Dhaka City" submitted by Tarun Kanti Magumdar, Roll No. 100104142, Session: October 2001 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of M. Engg. (Civil & Environmental) on 2nd March, 2005.

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I hereby certify that the research work embodied in this project report has been performed by the author under the supervision of Dr. Md. Delwar Hossain, Professor of the Department of Civil Engineering, BUET. Neither this thesis nor any part of it has been submitted or is being currently submitted else where for any other purpose (except for publications).

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Abstract

Dhaka city, the capital of Bangladesh, is surrounded by a circular river system. The river system includes the Turag river, Buriganga river, Dhaleswari river, Lakhaya river, Balu river and Tongi Khal. Sufficient quantity of water remains in the rivers during the five months of monsoon season but the flows are practically nil during the dry period except tidal backflow from the Meghna river. The river system receives solid wastes, sewage and wastewaters discharged from domestic, commercial and industrial activities both within and outside the city. These waste materials are tremendously deteriorating the water quality in the rivers. The contamination level reaches at such an alarming stage during dry periods that not only the ecosystem in the river collapses but also the water treatment plants of the city water supply system, developed based on the river water, virtually losses their expected quality of production. Besides, extensive dependency on groundwater for city supplies in the last decade has severely depleted the groundwater table. Thus, preservation of water quality in the river system is crucial for its sustainability as well as to have a probable alternative source to meet up demand of city water supplies. This study has put best efforts to give an overview about the present contamination scenario of the peripheral river system around the city including historical trend of the pollution.

It is observed that required dissolved oxygen (DO) for sustaining aquatic lives (5 mg/l) prevails only in the Dhaleswari river and in a very short downstream reach of the Lakhaya river throughout the year. The rest of the river reaches maintain lower DO level, usually less than 1 mg/l, in the dry period.

In consideration of drinking standards, the river water is contaminated by several parameters, which include organic matter, suspended solids and microorganisms. Ammonia level in different reaches of the river system is well above the permitted value specified in the United State Environmental Protection Agency (USEPA) guideline to avoid toxic effect on fishes. Concentrations of Nitrate (NO_3^-), Phosphate (PO_4^{3-}), Zinc (Zn), Chromium (Cr), Lead (Pb) and Mercury (Hg) in the river system are well below the allowable limits specified in different Environmental Quality Standards (EQS).

In general, water quality in the peripheral rivers is deteriorating day by day. The Dhaleswari river (Nabinagar to Kalagachia) and down stream of the Lakhaya river (Moshinabanda to Kalagachia) are the least polluted reaches. Minimum content of dissolve oxygen falls below 5 mg/l in the upstream of the Lakhaya river (Demra to Rupganj) although concentration of other pollutants is comparatively less. It is noteworthy that the Dhaleswari river (Nabinagar to Kalagachia) is the only reach that maintains suitable dissolved oxygen for fishes throughout the year.

The assessment from this study identifies that water of some least polluted river reaches like, the upper and lower reaches of the Lakhaya river (Demra to Rupganj and Siddhirganj to Kalagachia) and the Dhaleswari river (Nabinagar to Kalagachia) could be used in city water supply providing required treatment for few contaminants such as, organic matter, ammonia, suspended solids and microorganisms.

The study findings highlights that it is essential to make provisions for improving water quality in the peripheral rivers to sustain the city water supply system, the ecosystem in the rivers and, above all, the overall environment of the capital city.

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LIST OF ABBREVIATIONS

BOD	Biochemical Oxygen Demand
BUET	Bangladesh University of Engineering and Technology
BWDB	Bangladesh Water Development Board
COD	Chemical Oxygen Demand
DIFP	Dhaka Integrated Flood Protection
DND	Dhaka Narayanganj Demra
DO	Dissolved Oxygen
DOE	Department of Environment
DS	Dissolved Solids
DTW	Deep Tube Wells
DWASA	Dhaka Water Supply and Sewerage Authority
EC	Electrical Conductivity
EQS	Environmental Quality Standards
F. C.	Faecal Coliforms
GOB	Government of Bangladesh
IWM	Institute of Water Modelling
MOEF	Ministry of Environment and Forest
MLD	Million liter per day
PSTP	Pagla Sewage Treatment Plant
PWD	Public Works Department
RCC	Rainforcement Cement Concrete
SWTP	Sayedabad Water Treatment Plant
SS	Suspended Solids
SWMC	Surface Water Modelling Center
T. C.	Total Coliforms
TSS	Total Suspended Solid
EU	European Union
UNDP	United Nation Development Project
USA	United States of America
USEPA	United States Environmental Protection Agency
WHO	World Health Organization

INTRODUCTION

1.1 General

Water quality assessment is the overall process of evaluation of the physical, chemical and biological nature of the water. The main reason for the assessment of the quality of aquatic environment has been, traditionally, the need to verify whether the observed water quality is suitable for intended uses. Dhaka city is rich in both ground and surface water resources having an inherent problem of surface water pollution. Ground water is not yet being polluted but there is severe depletion of groundwater table under laying the city, which may jeopardize its lives and developments. The depletion is not only imposing harmful impacts on the geologic environment (water bearing strata) rather the city water supply may get a sudden severe catastrophe at any time since it is almost based on the ground water. It is very crucial to diversify the sources of water supplied for the city. Diminution of dependency on the groundwater and make provision to meet demand of the city from surface water is now very essential. The water bodies located in the periphery of the city comprise ample water even in the dry season. Domestic and industrial wastes generated in the city are deteriorating the water bodies gradually and even are jeopardizing their sustainability. A through assessment of water quality in the peripheral rivers is essential for their sustainability and also to rescue the city water supply from possible catastrophe.

Dhaka city is the nerve center of all activities in Bangladesh. The population of the city is rapidly increasing and the growing trend predicts it to become one of the most populated metropolises in the world. The present population of the city is around 12 million and has a growth rate is of about 3%. This huge population needs a lot of water for domestic uses. Commercial and industrial activities also consume a large volume of water. The present demand of water in the city is 2000 MLD. Dhaka Water Supply and Sewerage Authority (DWASA) tries its best to afford sufficient water for meeting up demand of the city.

The city is closely surrounded by a circular river system, which includes the Turag river, the Buriganga river, the Dhaleswari river, the Balu river, the Lakhya river and the Tongi Khal. The Dhaleswari and the Lakhya river comprise sufficient volume of water throughout the year. There are about 1500 industries in and around the Greater Dhaka, most of which are directly discharging their untreated wastes into either the sewerage system or the nearby drains or khal system. Huge quantities of domestic wastes are also generated from 12 million inhabitants of the city. Wastewater being discharged from major drains/khals contains domestic as well as industrial wastes and is ultimately disposed into the peripheral rivers. Since the peripheral river system gets no upstream inflows during dry season, the high waste loads deteriorate the water quality tremendously.

1.2 Objective of the Study

In spite of being a heart of the country, the Dhaka city is compromising a vital problem like scarcity of water for different uses like domestic, commercial and industrial. A circular water body surrounds the city, part of which holds sufficient water throughout the year. The water bodies have to assimilate wastewaters generated in the city and hence are extremely polluted during dry seasons. Dhaka Water Supply and Sewerage Authority (DWASA) is highly dependent on ground water for the water supply in the city, which is aggravating another threat causing a serious depletion of ground water table. The authority is now in dilemma. Surface water is available but not useable due to contamination and ground water lifting is not sensible concerning its depletion. There is requirement of water and provision would have to be made to eliminate scarcity of potable water.

To meet up the increasing demand of potable water in city supply, besides installing more deep tube wells (DTW) during the last decade, DWASA started operation of its surface water treatment plant (SWTP) at Sayedabad on July 27, 2002. The water being treated in the SWTP is lifted from the Lakhya River near Sarulia. From the inception of the SWTP (Sayedabad Water Treatment Plant) operation, the quality of raw water was found unsatisfactory in comparison with the treatment strategy being implemented. Recently, the intake water quality of the plant has been so much deteriorated that DWASA is seriously looking for an alternative intake point.

The specific objectives of the study are:

- To assess the water quality in the peripheral river system around the Dhaka city;
- To assess the trend of water pollution in the peripheral river system;
- To identify the least polluted river reaches where placement of the intake of city water supply can trim down treatment difficulties.

The outcome of the study will be useful in identifying alternatives for selection of sources of surface water of the city supply system so that dependency on the groundwater could be reduced and thereby depletion as well as possible contamination of ground water reservoir may be avoided. It will also help in drawing attention on the requirement of taking necessary steps for sustaining the ecosystem in the peripheral rivers.

1.3 Scope of the Study

Department of Environment (DOE) monitors water quality in the peripheral river system and reserves information of different locations. Water quality in the river system had also been monitored during several studies. Institute of water modeling had carried out a detail data campaign program to assess the deterioration of water quality at the intake point of Sayedabad Water Treatment Plant (SWTP). Therefore, there is a scope to evaluate the peripheral river system as a whole through integrating of all available scattered information and observations so that a recent pollution level in the entire peripheral river system can be outlined.

The scope of work of the study includes:

i) Procurement, organization and analysis of water quality data of the peripheral river system around the Dhaka city

ii) Assessment of long-term deterioration of water quality in the peripheral river system as far as possible

iii) Assessment of recent water quality scenario in the river system specially at the intakes of existing water treatment plants of DWASA

iv) Identification of river reaches which are comparatively less polluted specially with respect to drinking standards

1.4 Methodology

The steps that have been adopted to attain the objectives of the study are as follows:

- Recent stream water quality data of the peripheral river system has been procured from IWM and analyzed to assess the present water quality scenario.
- Wastewater quality data has been procured and analyzed to identify source, type and volume of pollution loads.
- Historical water quality data has been procured from DOE, IWM and different reports as well as publications to assess the trend of deterioration.

1.5 Organization of the Report

Chapter 2 describes the peripheral river system around the Dhaka city, surface and ground water resource in the city, water supply in the city. The chapter also deals with source, sink and sanitary significance of several water quality parameters important for maintaining drinking standard.

Chapter 3 describes the availability of water quality data that has been possible to be procured and taken into analysis.

Chapter 4 illustrates elaborately the present water quality scenario of the peripheral river system including historical trend of pollution with several parameters and discussion. It also describes the wastewater quality and pollution loads discharged into the river system through different wastewater outlets.

In chapter 5, concluding remarks have been made about the outcome of the study along with the relevant recommendations.

CHAPTER 2

LITERATURE REVIEW

2.1 General

The assessment of water quality comprises evaluation of the levels of content of different elements, compounds and materials co-existing with the water. It also necessitates dealing with characteristics of water body (extend, source, storage volume and hydraulics), characteristics of pollutants (source, volume and type) and climatic condition (specially temperature) for supplementing the evaluation. This chapter gives a brief about the peripheral river system around the Dhaka city including its extend, topography and hydraulic condition. It also describes the groundwater resource, depletion of groundwater table under laying the city, present water supply practice, sewage treatment facilities and sewage disposal system in the city. The details about the sources and sinks of pollutants identified so far including contamination levels in the river system have been broadly illustrated.

2.2 Peripheral River System around the Dhaka City

2.2.1 River Network

Six river reaches encompass the Dhaka city which include Tongi Khal, Turag river, Buriganga river, Dhaleswari river, Lakhya river and Balu river. There are some drainage khals inside the city such as, Dholai Khal, Begunbari Khal, Norai Khal and Kallayanpur Khal, which are linked with the peripheral rivers. Few of them are controlled through several structures. Drainage khals just work as wastewater as well as storm water carriers. The river network has been shown in Figure 2.1.

2.2.2 River Topography and Hydraulics

The river reaches have general slopes from north to south. The river system experience flood flows during monsoon from upstream inflows of the Turag, Dhaleswari and Lakhya river. The system gets no inflows during dry season. The rivers experience semi tidal influence in downstream reaches during flood seasons. Where as tidal back flows from the Upper Meghna river penetrate far upstream during dry periods.

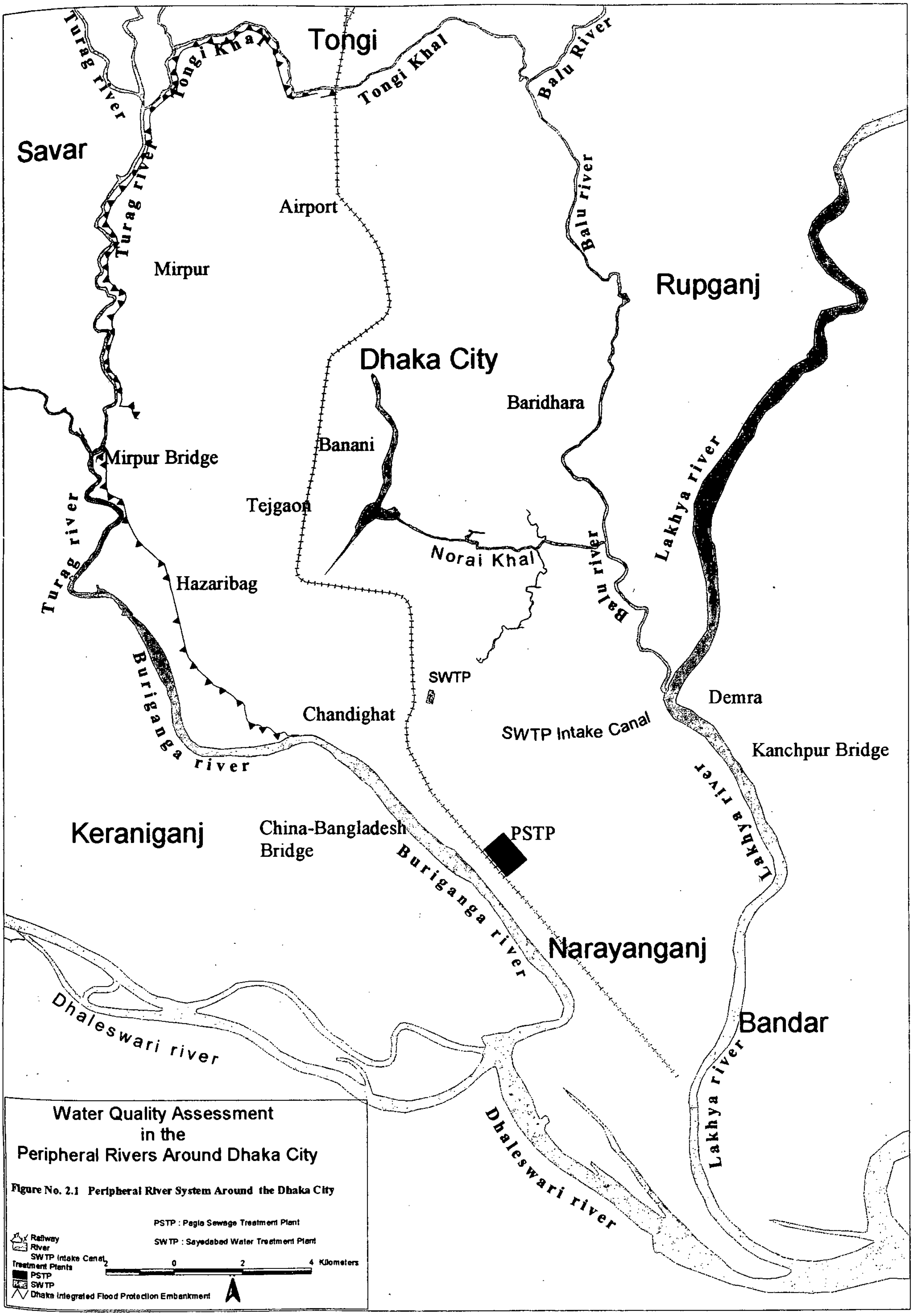


Figure No. 2.1 Peripheral River System Around the Dhaka City

2.3 Groundwater Depletion

The surface and subsurface geologic formations under Dhaka city are not favorable for replenishment and storage of groundwater against heavy withdrawal. Madhupur clay formation of the Pleistocene Age which is well dissected with reddish brown clay with silt and little very fine sand covers at the surface more than 80 % area of the city in the north, central and southwest regions. The Pleistocene deposits are underlain by recent deposits of gray and darkish clay. The infiltration rate of the Pleistocene clay varies from 1.00 mm to 3.00 mm per day in wet condition (UNDP, 1983) and that of the gray blackish clay is less than 1.0 mm/day.

The records of the groundwater level observed by Bangladesh Water Development Board (BWDB) for the year 1995 to 1999 indicate that the rate of annual declinations of groundwater level in Green road area were 2.70 m, 2.41 m and 2.52 m, respectively in the year 1997, 1998 and 1999 (SWMC, 2000). The depth of groundwater table from ground surface was 38.12 m in 1999. At Shewrapara, the annual declinations of groundwater level were 2.86 m, 2.06 m and 1.01 m during 1997, 1998 and 1999, respectively. Up to 1998, the average yearly declination of groundwater table within the city varied from 1.00 m to 2.50 m and that outside the city varied 0.30 m to 0.50 m (SWMC, 2000).

Ground water depths in Mohammedpur, Cantonment, Lalbagh and Dhanmondi were 20.76 m, 22.95 m, 26.92 m, 33.17 m, respectively in 1980 while at the end of 2002 it went down to 28.95 m, 36.44 m, 38.73 m and 41.38 m, respectively (IWM, 2004).

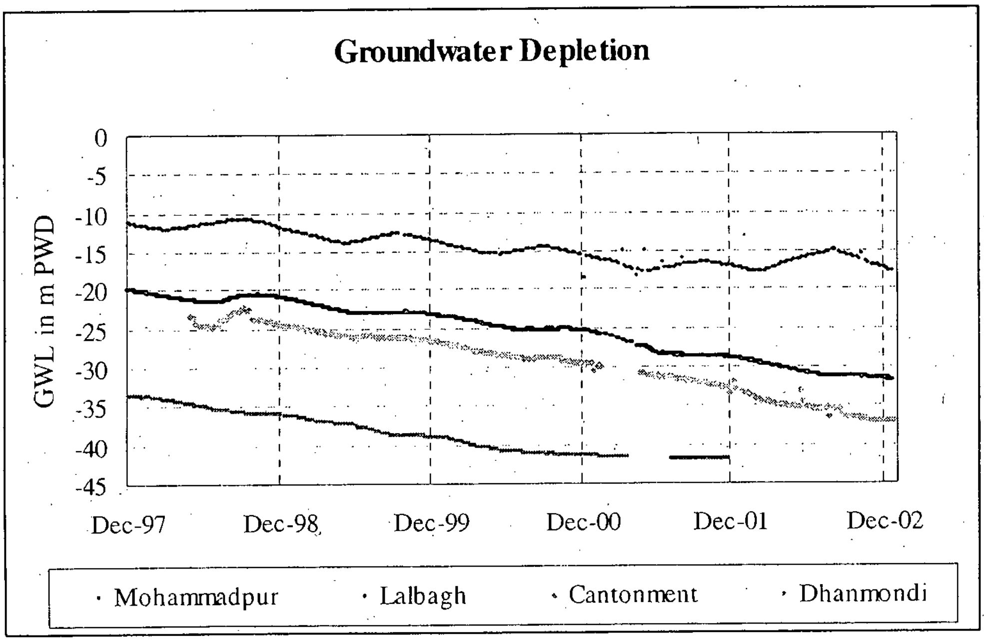


Figure 2.2: Depletion of ground water table at some locations in the Dhaka city (Source: IWM, 2004)

2.4 Water Supply in Dhaka City

Historically piped water supply in the Dhaka city started in 1876. The water treatment plant at Chandnighat was commissioned to address the water supply requirements at that time. Though, water supply in Dhaka started with surface water treatment but since early 1960s, it has mainly been dependent on the groundwater. The population of Dhaka city is around 12 million and the water demand is about 2000 MLD considering per capita consumption of 160 l/person/d. DWASA is capable of supplying only 1500 MLD. Production from surface water is 310 MLD out of which 225 MLD is from Sayedabad, 39 MLD from Chandnighat and 46 MLD from Narayanganj water treatment plants. The rest of the supply is satisfied from ground water through 382 DTW (1250 MLD). As a result, during the last few years, the ground water level has been declining drastically.

Table 2.1 Historical water supply scenarios in the Dhaka city (IWM, April 2004)

Year	Demand (MLD)	Supply (MLD)	% Demand	DTW (no.)
1963	150	130	87	30
1970	260	180	69	47
1980	550	300	55	87
1990	1000	510	51	140
1996	1300	810	62	216
1997	1350	870	64	225
1998	1400	930	66	237
1999	1440	1070	74	277
2000	1500	1130	75	308
2001	1600	1220	76	336
2002	1800	1550	86	394
Nov-2003	2000	1520	76	382

2.5 Sanitary Significance of Water Quality Parameters

2.5.1 Dissolved Oxygen (DO)

All living organisms in aqueous environment are dependent upon oxygen to maintain their metabolic processes. Environmental engineers are vitally concerned with "atmospheric conditions" that exists in liquid, water being the liquid in greatest abundance and importance. Oxygen is classified as poorly soluble in water, and since they do not react with water chemically, its solubility is directly proportional to partial pressure. The solubility of oxygen varies greatly with temperature over the range of interest to environmental engineers. The solubility of atmospheric oxygen in fresh waters ranges from 14.6 mg/l at 0^0C to about 7 mg/l at 35^0C under 1 atm of pressure. Rates of biological oxidation increase with temperature, and oxygen demand increases accordingly, high-temperature conditions, where dissolved oxygen is least, are of greatest concern to environmental engineers. Most of the critical conditions related to dissolved oxygen deficiency in environmental engineering practice occur during the summer months when temperature is high, solubility of oxygen is minimum and consuming rate is maximum.

For this reason it is customary to think of dissolved-oxygen levels of about 8 mg/l as being the maximum available under critical conditions. In polluted waters the saturation value is also less than that of clean water. The ratio of the value in polluted water to that in clean water is referred to as β value. The rate of solution of oxygen in polluted waters is normally less than in clean water and the ratio is referred to as the α value. They may range as low as 0.8 for β and 0.4 for α in some wastewaters. The low solubility of oxygen is the major factor that limits the purification capacity of natural waters and necessitates treatment of wastes to remove pollution matter before discharge to receiving streams.

In liquid wastes, dissolved oxygen is the factor that determines whether the biological changes are brought about by aerobic or by anaerobic organisms. The former use free oxygen for oxidation of organic and inorganic matter and produce innocuous end products, whereas the later bring about such oxidations through the reduction of certain inorganic salts such as sulfates, and the end products are often very obnoxious. Since both types of organisms are ubiquitous in nature, it is highly important that conditions favorable to the aerobic organisms (aerobic conditions) be maintained; otherwise the anaerobic organisms will take over, and development of nuisance conditions will result. Thus dissolved oxygen measurements are vital for maintaining aerobic conditions in natural waters that receive pollution matter and in aerobic treatment processes intended to purify domestic and industrial wastewaters.

Dissolved-oxygen determinations are used for a wide variety of other purposes. It is one of the most important single tests that the environmental engineers use. In most instances involving the control of stream pollution, it is desirable to maintain conditions favorable for the growth and reproduction of a normal population of fish and other aquatic organisms. This condition requires the maintenance of dissolved oxygen levels that will support the desired aquatic life in a healthy condition at all times. Determinations of dissolved oxygen serve as the basis of the BOD test; thus, they are the foundation of the most important determination used to evaluate the pollution strength of domestic and industrial wastes.

2.5.2 Biochemical Oxygen Demand (BOD)

By far the most widely deplored aspect of organic matter, notably human wastes, in water is the great quantify of oxygen required in aerobic degradation of the material in comparison with the capacity of water to dissolve free oxygen. The result is a depressing of the oxygen in water to levels inimical to aquatic life. Often this leads to anaerobic decomposition in receiving water, with all its objectionable odors and other resource destroying characteristics. As a measure of this oxygen demanding property of waste in water, a biochemical oxygen demand (BOD) test has been developed and is perhaps the best-known measure of water quality in the world. The "Ultimate BOD" of an organic waste is the amount of oxygen required by microorganisms in carrying out the aerobic cycles of carbon, nitrogen, sulfur, phosphorous, etc., that is, the amount of oxygen needed by bacteria in reducing organic matter to stable compounds. It is considered that a normal domestic sewage has a 5 day, 20^0C BOD of 200 to 250 mg/l, and the value for industrial wastes may be from 3000 mg/l to more than a dozen times that figure, where as a stream fully saturated with oxygen at 20^0C contains only 9.20 mg/l of oxygen (20 percent less in saltwater). It is easy to anticipate the quick depletion of dissolved oxygen in any receiving water unless the dilution factor is quite large. It is likewise evident why the oxygen demand of decomposing organic matter has long been the most used parameter of water quality (McGauhey, 1968).

2.5.3 Chemical Oxygen Demand (COD)

The concept of chemical oxygen demand (COD) is that all organic compounds, with but few exceptions, can be oxidized to carbon dioxide and water. In contrast with the BOD test, which measures only the biodegradable fraction, COD may measure toxic as well as biodegradable organic compounds. It is therefore applicable to many industrial wastes not readily analyzed for water quality factors by the sewage oriented BOD test (McGauhey, 1968).

2.5.4 Nitrogen (N)

The compounds of nitrogen are of great interest to environmental engineers because of the importance of nitrogen compounds in the atmosphere and in the life processes of all plants and animals. The chemistry of nitrogen is complex because of the several oxidation states that nitrogen can assume and the fact that changes in oxidation state can be brought about by living organisms. To add even more interest, the oxidation state changes wrought by bacteria can be either positive or negative depending upon whether aerobic or anaerobic conditions prevail.

From the viewpoint of inorganic chemists, nitrogen can exist in seven oxidation states, and compounds in all are of interest to them.

$$\overset{-III}{NH_3} - \overset{0}{N_2} - \overset{I}{N_2O} - \overset{II}{NO} - \overset{III}{N_2O_3} - \overset{IV}{NO_2} - \overset{V}{N_2O_5}$$

However, in aquatic systems only a few of the oxidation states dominate and these are the ones of most importance to the environmental engineers concerned with water quality. These forms may be summarized as follows:

$$\overset{-III}{NH_3} - \overset{0}{N_2} - \overset{III}{N_2O_3} - \overset{V}{N_2O_5}$$

Organic
derivatives

N_2O_3 and N_2O_5 are the acid anhydrides of nitrous and nitric acids

During electrical storms large amounts of nitrogen are oxidized to N_2O_5, and its union with water produces HNO_3, which is carried to the earth in the rain. Nitrates are also produced by direct oxidation of nitrogen or of ammonia in the production of commercial fertilizers. The nitrates serve to fertilize plant life and are converted to proteins.

$$NO_3^- + CO_2 + \text{green plants} + \text{sunlight} \rightarrow \text{protein}$$

Atmospheric nitrogen is also converted to proteins by "nitrogen fixing" bacteria.

$$N_2 + \text{special bacteria} \rightarrow \text{protein}$$

In addition, ammonia and ammonium compounds are applied to soils to supply plants with ammonia for further production of proteins.

$NH_3 + CO_2$ + green plants + sunlight $\rightarrow$ protein

Animals and human beings are incapable of utilizing nitrogen from the atmosphere or from inorganic compounds to produce proteins. They are dependent upon plants or other animals that feed upon plants to provide protein, with exception of ruminants. In any event, nitrogen compounds are released in the waste products of the body during life. At death the proteins stored in the body become waste matter for disposal. The urine contains the nitrogen resulting from the metabolic breakdown of proteins. The nitrogen exists in urine principally as urea, which is hydrolyzed rather rapidly by the enzyme urease to ammonium carbonate:

$$C(=O)(NH_2)_2 + 2H_2O \xrightarrow[\text{urease}]{\text{enzyme}} (NH_4)_2CO_3$$

The feces of animals contain appreciable amounts of unassimilated protein (organic nitrogen). It and protein remaining in the bodies of dead animals and plants are converted in large measure to ammonia by the action of heterotrophic bacteria, under aerobic or anaerobic conditions:

$$\text{Protein (organic N)} + \text{bacteria} \rightarrow NH_3$$

Some nitrogen always remains in non-digestible matter and becomes part of the non-digestible residue sink. As such it becomes part of the detritus in water or sediments, or humus in soils.

The ammonia released by bacterial action on urea and proteins may be used by plants directly to produce plants protein. If it is released in excess of plants requirements, the excess is oxidized by autotrophic nitrifying bacteria. The nitrosomonas group, known as the nitrite formers, convert ammonia under aerobic conditions to nitrites and derive energy from the oxidation:

$$2NH_3 + 3O_2 \xrightarrow{\text{bacteria}} 2NO_2^- + 2H^+ + 2H_2O$$

The nitrites are oxidized by the Nitrobacter group of nitrifying bacteria, which are also called the nitrate formers.

$$2NO_2^- + O_2 \xrightarrow{\text{bacteria}} 2NO_3^-$$

The nitrates formed may serve as fertilizer for plants. Nitrates produced in excess of the needs of plant life are carried away in water percolating through the soil because the soil does not have the ability to hold them. This frequently results in relatively high concentrations of nitrates in groundwater.

Under anaerobic conditions nitrates and nitrites are both reduced by a process called denitrification. Presumably nitrates are reduced to nitrites, and then reduction of nitrites occurs. Reduction of nitrites is carried all the way to ammonia by a few bacteria, but most of them carry the reduction to nitrogen gas, which escapes to the atmosphere.

Environmental Significance

Analyses for nitrogen in its various forms have been performed on potable and polluted waters ever since water was confirmed to be a vehicle for the transmission of disease. The determination served as one basis of judging the sanitary quality of water for a great many years. Today nitrogen analyses are performed largely for other reasons.

An Indicator of Sanitary Quality: Prior to the development of bacteriological tests for determining the sanitary quality of water, environmental engineers and others concerned with the public health were largely dependent upon chemical tests to provide circumstantial evidence of the presence of contamination. Chemists working with wastes and freshly polluted waters learned that most of the nitrogen is originally present in the form of organic (protein) nitrogen and ammonia. As time progresses, the organic nitrogen is gradually converted to ammonia nitrogen, and later on, if aerobic conditions are present, oxidation of ammonia to nitrites and nitrates occurs. The progression of events was found to occur somewhat as shown in Figure 3.1, and more refined interpretations of the sanitary quality of water were based upon this knowledge. For example, waters that contained mostly organic and ammonia nitrogen were considered to have been recently polluted and therefore of great potential danger. Waters in which most of the nitrogen was in the form of nitrates were considered to have been polluted a long time previously and therefore offered little threat to the public health. The bacteriological test for coliform organisms provides circumstantial evidence of much greater reliability concerning the hygienic safety of water, and it has eliminated the need for extended nitrogen analysis in most water supplies.

In 1940 it was found that drinking waters with nitrate content often caused methemoglobinemia in infants. From extended investigations it has been concluded that the nitrate content should be limited. For this reason, the U.S. Environmental Protection Agency has set a maximum contaminant level requiring that the nitrate-nitrogen concentration not exceed 10 mg/l in public water supplies.

Oxidation in River and Estuaries: The autotrophic conversion of ammonia to nitrites and nitrates requires oxygen, and so the discharge of ammonia nitrogen and its subsequent oxidation can seriously reduce the dissolved-oxygen levels in rivers and estuaries, especially where long residence times required for the growth of the slow-growing nitrifying bacteria are available. Also these organisms are produced in large numbers by highly efficient aerobic biological waste treatment systems and their discharge with the treated effluent can cause rapid nitrification to occur in waterways. Disinfection of effluents with chlorine has minimized this problem. Nitrogen analyses are important in assessing the possible significance of the problem, and in the operation of treatment processes designed to reduce ammonia discharge.

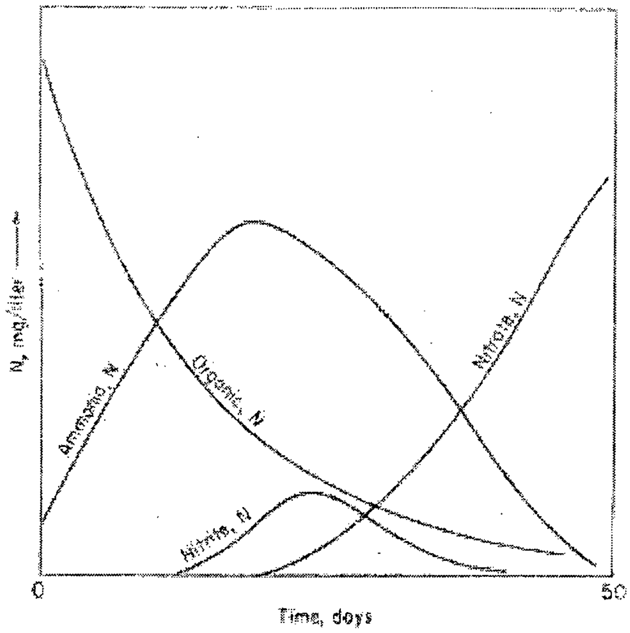


Figure 2.3: Changes occurring in forms of nitrogen present in polluted water under aerobic condition (Source: Sawyer, etal, 1994)

Control of Biological Treatment Processes: Determinations of nitrogen are often made to control the degree of purification produced in biological treatment. With the use of the BOD test, it has been learned that effective stabilization of organic matter can be accomplished without carrying the oxidation into the nitrification stage. This results in a material saving of time and air required where ammonia removal is not otherwise mandated.

Nitrogen control has become an important consideration in the design and operation of wastewater treatment plants for reasons cited above. In some states limitations have been imposed because of suspected toxic effects upon fish life. It is well known that un-ionized ammonia is toxic but that the ammonia ion is not. Since the relationship between the two is pH dependent,

$$NH_3 + H^+ = NH_4^+$$

a discussion is in order. Figure 3.2 shows the relationship between free ammonia and ammonium ion that exists for several concentrations of ammonia nitrogen over the pH range of interest in most natural waters. Free ammonia in concentrations above about 0.2 mg/l can cause fatalities in several species of fish. Applying the usual safety factor, a National Academy of Sciences – National Academy of Engineering Committee has recommended that no more than 0.02 mg/l free ammonia be permitted in receiving waters. It is safe to conclude that ammonia toxicity will not be a problem in receiving waters with pH below 8 and ammonia nitrogen concentration less than about 1 mg/l

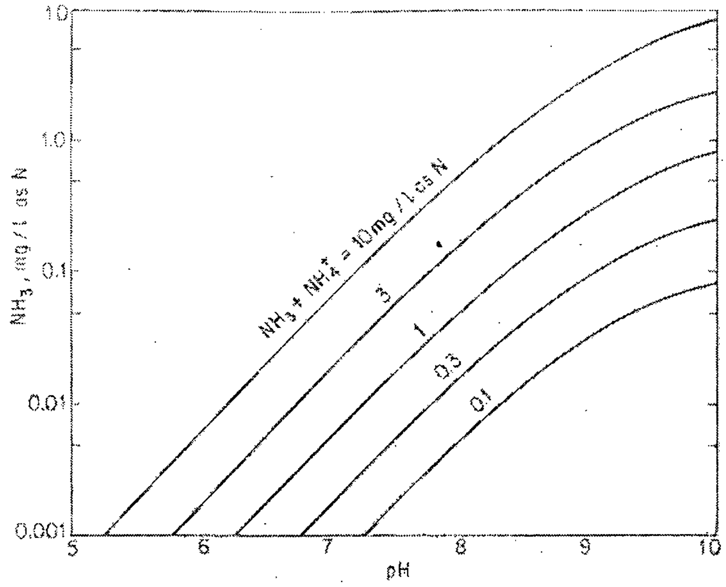


Figure 2.4 The effect of pH and ammonia nitrogen concentration ($NH_3 + NH_4^+$) on the concentration of free ammonia in water (Source: Sawyer, etal, 1994)

Application of Nitrogen Data

Data concerning the nitrogen compound that exist in drinking water supplies are used largely in connection with disinfection practice. The amount of ammonia nitrogen present in a water determines to a great extent the chlorine needed to obtain free chlorine residuals in breakpoint chlorination and determines to some extent the ratio of monochloramines to dichloramines when combined chlorine residuals are involved.

Nitrate determinations are important in determining whether water supplies meet U.S. Environmental Protection Agency maximum contaminant levels for the control of methemoglobinemia in infants.

By controlling nitrification aerobic treatment costs can be kept at a minimum. Ammonia and organic nitrogen analyses are important in determining whether sufficient available nitrogen is present for biological treatment.

The productivity of natural waters in terms of algal growths is related to the fertilizing matter that gains entrance to them. Reduced forms of nitrogen are oxidized in natural waters, thereby affecting the dissolved oxygen resources.

2.5.5 Solids

Strictly speaking, all matter except the water contained in liquid materials is classified as solid matter. The usual definition of solid, however, refers to the matter that remains as residue upon evaporation and drying at 103 to 105^{0}C.

In potable waters, most of the matter is in dissolved form and consists mainly of inorganic salts, small amounts of organic matter, and dissolved gasses. The total dissolved solids content of potable waters usually ranges from 20 to 1000 mg/l, and as a rule, hardness increases with total dissolved solids. The undissolved substances are usually referred to as suspended matter or suspended solids, which is completely unexpected for water supplies.

2.5.6 Iron and Manganese

Both iron and manganese create serious problems in public water supplies. The problems are most extensive and critical with underground waters, but difficulties are encountered at certain seasons of the year in waters drawn from some rivers and some impounded surface supplies. Iron exists in soils and minerals mainly as insoluble ferric oxide and iron sulfide (pyrite). It occurs in some areas also as ferrous carbonate (siderite), which is very slightly soluble. Since ground waters usually contain significant amount of carbon dioxide, appreciable amounts of ferrous carbonate may be dissolved by the reaction shown in the equation

$$FeCO_3 + CO_2 + H_2O \rightarrow Fe^{2+} + 2HCO_3^-$$

Under reducing (anaerobic) conditions, the ferric iron (Fe-III) is reduced to ferrous iron (Fe-II), and solution occurs without difficulty. Manganese exists in the soil principally a manganese dioxide, which is very insoluble in water containing carbon dioxide. Under reducing (anaerobic) conditions, the manganese in the dioxide form is reduced from an oxidation state of Mn (IV) to Mn (II), and solution occurs.

As far as is known, humans suffer no harmful effects from drinking waters containing iron and manganese. Water reach with iron and manganese become turbid and highly unacceptable from an aesthetic viewpoint when exposed to the air. Both iron and manganese interfere with laundering operations, impart objectionable stains to plumbing fixtures, and cause difficulties in distribution systems by supporting growth of iron bacteria. Iron also imparts a taste to water, which is detectable at very low concentrations. For these reasons public water supplies ought not to contain more than 0.30 mg/l of iron or 0.05 mg/l of manganese, the U.S. Environmental Protection Agency secondary maximum contaminant levels.

2.5.7 Sulfate

The sulfate ion is one of the major anions occurring in natural waters. It is of importance in public water supplies because of its cathartic effect upon humans when it is present in excessive amounts. For this reason the recommended upper limit is 250 mg/l in waters intended for human consumption. Sulfates are important in both public and industrial water supplies because of the tendency of waters containing appreciable amounts to form hard scales in boilers and heat exchangers.

Under anaerobic conditions, the sulfate ion is reduced to sulfide ion and at pH levels below 7 cause serious odor problems. Concentrations in air above 20 ppm should be avoided because of toxicity. Hydrogen sulfide is indirectly responsible for crown corrosion of gravity type sewers.

Combustion of fossil fuels leads to formation of gaseous oxides of sulfur, which hydrolyze when dissolved with rainwater to form sulfuric acid. The resulting "acid rain" is of concern.

2.5.8 Fluoride

Cryolite (Na_3AlF_6) is used as a solvent for Al_2O_3 in the electrolytic method of producing aluminum. At operating temperatures, the cryolite is molten and exerts a considerable vapor pressure. As a result, appreciable amounts of fluorides escape to the atmosphere through exhaust systems. The fluorides condense to form a smoke, and much of the particulate matter settles on vegetation and the soil in the immediate area.

Environmental engineers are concerned about the optimum level of fluoride in the public water supplies. According to the U.S. Environmental Protection Agency, the maximum contamination level for fluoride is 4 mg/l to protect against crippling skeletal fluorosis. Also, a secondary maximum contamination level of 2 mg/l has been set to protect against objectionable dental fluorosis. Approximately, 1 mg/l of fluoride ion is desirable in public waters for optimal dental health. At decreasing levels, dental caries becomes a serious problem, and increasing levels, dental fluorosis becomes a problem.

2.5.9 Phosphorous and Phosphate

The most common forms of phosphorus are **organically bound phosphorus compounds, orthophosphate** and **polyphosphates**. The latter, such as sodium **hexametaphosphate,** gradually hydrolyze in aqueous solution to the orthoform, and bacterial decomposition of organic compounds releases orthophosphates.

The principal sources of phosphorus are **domestic wastewater** and **agricultural return water**. Thirty to fifty percent of the phosphorus in domestic wastewater is from sanitary wastes, while the remaining 50 to 70 percent is attributable to phosphate builders used in household detergents. Total phosphorus contribution is about 3.50lb per capita per year resulting in an average concentration of 10 mg/l domestic waste. Typically, the phosphorus enters the wastewater from human body wastes, from food wastes discharged to the sewers from kitchen grinders, and from the condensed inorganic phosphate compounds used in various household detergents. Polyphosphates are extensively used in synthetic detergents and often contribute up to one half the phosphorus in wastewater. Commercial washing and cleaning compounds are also a source of phosphates.

Domestic wastewater is relatively rich in phosphorous compounds. Prior to the development of synthetic detergents, the content of inorganic phosphorous usually ranged from 2 to 3 mg/l and organic forms varied from 0.50 to 1.0 mg/l. Most of the inorganic phosphorous was contributed by human wastes as a result of the metabolic breakdown of proteins and elimination of the liberated phosphates in the urine. The amount of phosphorous released is a function of protein intake.

Most heavy-duty synthetic detergent formulations designed for the household market contain large amounts of phosphates as "builders". Many of them contain from 12 to 13 percent phosphorous or over 50 percent of polyphosphates. Domestic wastewater probably contains from two to three times as much inorganic phosphorous at the present time as it did before synthetic detergents became widely used.

Phosphates are used in some public water supplies as a means of controlling corrosion. They are also used in some softened waters for stabilization of calcium carbonate to eliminate the need for recarbonation. Phosphates compounds are widely used in steam power plants to control scaling in boilers.

The free swimming and floating organisms in the surface water supplies are called plankton. The plankton are composed of animals, zooplankton, and plants, phytoplankton. The later are predominantly algae and cyanobacteria. Nitrogen and phosphorous are both essential for the growth of algae and cyanobacteria. Where both nitrogen and phosphorous are plentiful, algal blooms occur which produce variety of nuisance conditions. The critical level for inorganic phosphorous has been established as 0.005 mg/l or 5 μ g/l under summer growing condition. Phosphorous interferes with coagulation and lime soda softening processes.

2.5.10 Turbidity

The term turbid is applied to water containing suspended matter that interferes with the passage of light through the water or in which visual depth is restricted. Turbidity may be caused by wide variety of suspended materials, which range in size from colloidal to coarse dispersions, depending upon the degree of turbulence. In lake or other waters existing under relatively quiescent conditions, most of the turbidity will be due to colloidal and extremely fine dispersions. In rivers under flood conditions, most of the turbidity will be due to relatively coarse dispersions.

In glacier-fed rivers and lakes most of the turbidity is due to colloidal rock particles produced by the grinding action of the glacier. As rivers descend from mountain areas onto the plains, they receive contributions of turbidity from farming and operations that disturbed the soil. As the rivers progress toward the ocean, they pass through urban areas where domestic and industrial wastewaters may be added.

Turbid water is aesthetically unacceptable to the consumers of public water supplies. Any turbidity in the drinking water is automatically associated with possible wastewater pollution and the health hazards occasioned by it. Filtration of water is rendered more difficult and costly when turbidity increases. During disinfection of public water supplies pathogenic organisms may be encased in the particles and protected from the disinfectants.

To avoid above difficulties, the U.S. Environmental Protection Agency has placed a maximum contamination level of 0.5 to 1.0 units of turbidity, depending upon the treatment process used, as the maximum amount allowable in public water supplies.

2.5.11 Color

The coloring material results from contact of the water with organic debris, such as leaves, needles of conifers, and wood, all in various stages of decomposition. It consists of vegetable extracts of a considerable variety. Tannins, humic acid, and humates, from the decomposition of lignin, are considered to be the principal color bodies. The lignin derivatives are highly colored and quite resistant to biological attack. Iron is sometimes present as ferric-hamate and produces a color of high potency. Surface waters may become colored by pollution with highly colored wastewaters from dyeing operations in the textile industry and from pulping operations in the paper industry

Color caused by suspended matter is referred to a apparent color. True color is caused by vegetable or organic extracts that are colloidal. Waters containing coloring mater derived from natural substances are not generally considered to possess harmful or toxic properties. The natural coloring materials give a yellow-brownish appearance to the water, somewhat like that of urine, and there is a natural reluctance on the part of water consumers to drink such waters. Waters intended for human use should not have a color exceeding 15 units, the recommended or secondary maximum contaminant level set by the U.S. Environmental Protection Agency.

2.5.12 Alkalinity

The alkalinity of a water is a measure of its capacity to neutralize acids. The alkalinity of natural waters is primarily due to the salts of weak acids, although weak or strong bases may also contribute. Although many materials may contribute to the alkalinity of a water, the major portion of the alkalinity in natural waters is caused by three major classes of materials which may be ranked in order of their association with high pH values as follows: (1) hydroxide, (2) carbonate, and (3) bicarbonate. Water having bicarbonate alkalinity shows pH value 8.3 or less. Carbonate alkalinity is associated with higher pH value like 8.5 or more. pH value well above 10 is common in waters having hydroxide alkalinity.

As far as is known, the alkalinity of water has little public health significance. Highly alkaline waters are usually unpalatable. Chemically treated waters sometimes have rather high pH values, which have met with some objection on the part of consumers. Information concerning alkalinity is used in a variety of ways in environmental engineering practice like chemical coagulation, water softening, corrosion control, acid buffer capacity and industrial wastes disposal.

2.6 Environmental Quality Standard (EQS)

The Environmental Quality Standards (EQS) of relevant parameters set out by the DOE (DOE, 1991) for fishing, recreational and irrigation water are as shown in Table 2.2a. The Ministry of Environment and Forest (MOEF) published EQS in a Gazette (Bangladesh Gazette, Addendum, on 28 August in 1997 (MOEF, 1997) for environmental protection and management in the working level. Besides, there are several guidelines provided by different countries or organizations like United State Environmental Protection Agency (USEPA), World Health Organization (WHO), European Union (EU), Canada and Russia. Table 2.3 describes the allowable limits of different inorganic water quality parameters for drinking waters specified by USEPA, WHO and Bangladesh. Table 2.4 describes maximum allowable concentrations of water quality variables for drinking provided by WHO, EU, Canada, USA and Russia. Table 2.5 describes maximum allowable concentrations of water quality variables for fisheries and other aquatic lives.

Table 2.2a EQS of some relevant water quality parameters, DOE 1991

Parameter	Recreational	Fishing	Irrigation
Total Alkalinity, mg/l	NYS	70-100	NYS
Ammonia (NH_3), mg/l	2	0.025	3
Ammonical Nitrogen (as N), mg/l	NYS	1.2	15
BOD (ultimate), mg/l	3	6	10
Chloride (as Cl), mg/l	600	600	600
COD, mg/l	4	NYS	NYS
Chromium, mg/l	NYS	0.05	NYS
Coliform (total), Nos./100 ml	NYS	NYS	10
DO, mg/l	4-5	4-6	5
Nitrate (as N), mg/l	NYS	NYS	NYS
PH	6-9.5	6.5-8.5	6.0-8.5
SS, mg/l	20	25	NYS

Source: Kamal, 1996

Table 2.2b EQS of some relevant water quality parameters, DOE 1997

Parameter	Recreational	Fishing	Irrigation
PH	6.5-8.5	6.5-8.5	6.5-8.5
BOD (ultimate), mg/l	<= 3	<= 6	<= 10
DO, mg/l	>= 5	>= 5	>= 5
Total Coliform (No./100 ml)	<= 200	<=5000	<=1000
Ammonical Nitrogen (as N), mg/l	-	<= 1.2	-
Electrical Conductivity (μmho/cm)	-	-	2250

(Source: Bangladesh Gazette, Addendum, 28th August 1997)

Table 2.3 Drinking water quality standards (Source: Ahmed, etal, 2001)

Parameter	USEPA (2000)	WHO (1993)	Bangladesh (GOB, 1997)
Aluminum (mg/l)	0.05-0.20	0.20	0.1 (0.2)
Antimony (mg/l)	0.006	0.005	
Arsenic (mg/l)	0.01	0.01	0.05
Barium (mg/l)	2.0	0.70	1.0
Bromide (mg/l)	10		10
Calcium (mg/l)			75 (200)
Cadmium (mg/l)	0.005	0.003	0.01
Chloride (mg/l)	250	250	200 (600)
Chromium (mg/l)	0.10	0.05	0.05
Copper (mg/l)	1.31	0-2.0	1.5
Fluoride (mg/l)	2.0	1.50	1.0
Hardness as $CaCO_3$ (mg/l)	100 – 500	-	200 – 500
Iron (mg/l)	0.30	0.30	0.30 (1.0)
Lead (mg/l)	0.015	0.01	0.10
Manganese (mg/l)	0.1	0.1-0.05	0.10 (0.5)
Nickel (mg/l)	0.10	0.02	
Nitrate (mg/l)	10	50	10
Nitrite (mg/l)	1		
Phosphate (mg/l)	0.005		6.0

Parameter	USEPA (2000)	WHO (1993)	Bangladesh (GOB, 1997)
PH	6.5 – 8.5	6.5 – 8.5	6.5 – 8.5
Selenium (mg/l)	0.05	0.01	
Silver (mg/l)	0.10		
Sodium (mg/l)		200	
Sulfate (mg/l)	250	250	400
TDS (mg/l)	400 – 500	1000	500 (1500)
Zinc (mg/l)	5.0	3.0	5 (15)

Bangladesh standard values are given as maximum desirable concentration with maximum permissible concentration in parentheses.

Table 2.4 Maximum allowable concentrations of water quality variables for drinking (Source: Chapman, 1996)

Use Variable	WHO	EU	Canada	USA	Russia
Colour (TCU)	15	20 Pt-Co	15	15	20
Total dissolved solids (mg/l)	1000		500	500	1000
Total suspended solid (mg/l)					
Turbidity (NTU)	5	4 JTU	5	0.5 – 1.0	
PH	< 8.0	6.5 – 8.5	6.5 – 8.5	6.5 – 8.5	6.0 – 9.0
Dissolved Oxygen (mg/l)					4.0
Ammoniacal nitrogen (mg/l)					2.0
Ammonium (mg/l)		0.50			2.0
Nitrate as N (mg/l)			10	10	
Nitrate (mg/l)	50	50			45
Nitrite as N (mg/l)			1.0	1.0	
Nitrite (mg/l)	3 (P)	0.1			3.0
Phosphorus (mg/l)		5.0			
BOD (mg/l O_2)					3.0
Sodium (mg/l)	200	150			
Chloride (mg/l)	250	25	250	250	350
Chlorine (mg/l)	5				
Sulphate (mg/l)	250	250	500	250	500
Sulphide (mg/l)			0.05		
Fluoride (mg/l)	1.5	1.5	1.5	2.0	< 1.5
Boron (mg/l)	0.30	1.0	5.0		0.30
Cyanide (mg/l)	0.07	0.05	0.2	0.2 (PP)	0.07
Aluminum (mg/l)	0.2	0.2			0.50
Arsenic (mg/l)	0.01 (P)	0.05	0.05	0.05	0.01
Barium (mg/l)	0.7	0.1	1.0	2.0	0.7
Cadmium (mg/l)	0.003	0.005	0.005	0.005	0.003
Chromium (mg/l)	0.05 (P)	0.05	0.05	0.10	0.05
Cobalt (mg/l)					0.10
Copper (mg/l)	2 (P)	0.1 – 3.0	1.0	1	2.0
Iron (mg/l)	0.3	0.2	0.3	0.3	0.3
Lead (mg/l)	0.01	0.05	0.05	0.015	0.01
Manganese (mg/l)	0.5 (P)	0.05	0.05	0.05	0.5
Mercury (mg/l)	0.001	0.001	0.001	0.002	0.001
Nickel (mg/l)	0.02	0.05			0.02
Selenium (mg/l)	0.01	0.01	0.01	0.05	0.01
Zinc (mg/l)	3	0.1 – 5.0	5.0	5	5.0
Oil and petroleum products (µg/l)		0.01			0.10

Use Variable	WHO	EU	Canada	USA	Russia
Total pesticides (μg/l)		0.5	100		
Aldrin & dieldrin (μg/l	0.03		0.7		
DDT (μg/l)	2		30.0		2.0
Lindane (μg/l)	2		4.0	0.2	2.0
Methoxychlor (μg/l)	20		100	40	
Benzene (μg/l)	10			5	
Pentachlorophenol (μg/l)	9 (P)			10	10
Phenols (μg/l)		0.5	2		1.0
Detergents (μg/l)		0.2		0.5	0.5
Faecal Coliforms (E. Coli) (No. per 100 ml)	0	0	0		0
Total Coliforms (No. per 100 ml)	0		10	1	0.3

Table 2.5 Maximum allowable concentrations of water quality variables for Fisheries and other aquatic lives (Source: Chapman, 1996)

Use Variable	EU	Canada	Russia
Total suspended solids (mg/l)	25	10	
PH	6.0 - 9.0	6.5 - 9.0	
Dissolved Oxygen (mg/l)	5.0 - 9.0	5.0 – 9.0	4.0 – 6.0
Ammoniacal nitrogen (mg/l)	0.005 – 0.025	1.37 – 2.2	0.05
Ammonium (mg/l)	0.04 – 1.0		0.50
Nitrate (mg/l)			40
Nitrite (mg/l)	0.01 – 0.03	0.06	0.08
BOD (mg/l O_2)	3.0 – 6.0		3.0
Sodium (mg/l)			120
Chloride (mg/l)			300
Chlorine (mg/l)		0.002	
Sulphate (mg/l)			100
Fluoride (mg/l)			0.75
Cyanide (mg/l)		0.005	0.05
Aluminum (mg/l)		0.005 – 0.1	
Arsenic (mg/l)		0.05	
Cadmium (mg/l)		0.0002 – 0.0018	0.005
Chromium (mg/l)		0.02 – 0.002	0.02 – 0.005
Cobalt (mg/l)			0.01
Copper (mg/l)	0.005 – 0.112	0.002 – 0.004	0.001
Iron (mg/l)		0.30	0.10
Lead (mg/l)		0.001 – 0.007	0.10
Manganese (mg/l)			0.01
Mercury (mg/l)		0.0001	0.00001
Nickel (mg/l)		0.025 – 0.12	0.01
Selenium (mg/l)		0.001	0.0016
Zinc (mg/l)		0.03	0.01
Oil and petroleum products (μg/l)			0.05
Aldrin & dieldrin (μg/l		4 ng/ll	
DDT (μg/l)		1 ng/l	
Benzene (μg/l)		300	
Phenols (μg/l)		1.0	1.0
Detergents (μg/l)			0.1

2.7 Sources of Pollution

Pollutants are generated in and around the city through domestic, commercial and industrial activities. Wastewaters and sewage generated in the city are carried into the river system through numerous outlets. Solid wastes are collected by the city corporation and dumped on the open land. According to the Industrial Management Control Task Report (BKH, 1994) six clusters of industries are located in the Dhaka and Narayanganj city. BOD_5 loads of the major individual industries within the cluster had been estimated by the aforementioned authority, which are as shown in Table 2.6.

Table 2.6 Industries in and around the Dhaka City (Source: WSP, 1998)

Cluster Name	Type of Industry	Number of Industries	Total Wastewater Discharge (m^3/day)	Total BOD Load (kg/day)	Discharge into
Hazaribagh	Leather	136	15800	17,600	Turag
Tongi BSCIC	Textiles	13	4300	4400	Tongi Khal
Fatulla	Textiles	6	3400	3850	Buriganga
Kanchpur	Textiles	9	4300	3480	Lakhaya
Tejgaon	Textiles, Chemical	16 27	3350 535	1960 475	Begunbari Khal
Tarabo	Textiles	14	1150	1475	Lakhaya

The study also expressed that the real figure of industries in and around the Greater Dhaka was more than the number specified in Table 2.6, which was expected to around 1500.

2.7.1 Point Sources of Pollution

Point sources of Pollution of the Turag, Buriganga and Dhaleswari Rivers: The study team of Fourth Dhaka Water Supply identified that the major point sources contributing pollutants in the Turag, Buriganga and Dhaleswari rivers are divided broadly into three groups:

- Group-I — Sluice Gates along the Dhaka Integrated Flood Protection (DIFP) Embankment.
- Group-II — City drains along the Buriganga river including Dholai Khal.
- Group-III — Outfalls from the Pagla Sewage Treatment Plant and Kashipur Khal.

The three groups of sources of pollution have been described in the following tables (Table 2.7.a, Table 2.7.b and Table 2.7.c)

Table 2.7.a Point Sources of Pollution, Group-I (Source: WSP, 1998)

Source	Description	Drain into
Sluice No. S-1, S-2 and S-3	Drain irrigation drainage water through Diabari and Abdullahpur Khal	Tongi Khal
Sluice No. S-4	Drains Mirpur 12, Pallabi, and adjoining low-lying areas through Degun Khal	Turag River
Sluice No. S-5	Drains Mirpur Section A, B and C through a branch of the Kallayanpur Khal	Turag River
Sluice No. S-6	Drains Mohammadpur, Darussalam, Kallayanpur and adjoining areas through Kallayanpur Khal	Turag River
Sluice No. S-7	Drains tannery waste of Hazaribagh along with domestic wastes of Rayer Bazar, Nimtala, Sultanganj, Zigatala, Charakghata, Nawabganj, Gajmahal, Kantasur and West Dhanmondi	Turag River
Sluice No. S-8	Drains small portion of tannery waste and wastewater of Borhanpur, Kanipara, and Battala Majar areas	Buriganga River
Sluice No. S-9	Drains wastewater from (unsewered or partially sewered) Pilkhana, Enayetganj, Ganaktuli, Azimpur, Bhagalpur, and Nawabganj	Buriganga River
Sluice No. S-10	Drains wastewater from Shahidnagar, Balughat, and Amligola.	Buriganga River
Sluice No. S-11		Buriganga River

Table 2.7.b Point Sources of Pollution, Group-II (Source: WSP, 1998)

Source	Description	Drain into
Dholai Khal	Drains storm water of entire Old Dhaka, and adjoining Gandaria and Jatrabari areas. It also drains wastewater of some areas.	Buriganga river
Fourty city drains	The drain span from Postagala-Shashanghat to Babubazar. Some of the outlets of these drains are made of Iron pipes or RCC pipes. Some of these are Brick drains and the rest are natural earthen canals. These drains carry wastewater as well as storm water.	Buriganga river

Table 2.7.c Point Sources of Pollution, Group-III (Source: WSP, 1998)

Source	Description	Drain into
Pagla Sewage Treatment Plant	Discharges treated effluent; Design flow, BOD and SS are 96000 m^3/day (average), 50 mg/l and 60 mg/l, respectively. The PSTP authority reported that the effluent water quality could not be maintained due to discharge of industrial waste in the influent.	Buriganga River
Kashipur Khal	Discharges wastewater from small industries and Textile dyeing mills of Kashipur, Narayanganj	Dhaleshari River

Points sources of Pollution of the Lakhya river: The point sources of pollution of the Lakhya river are as shown in Table 2.7.d

Table 2.7.d Point Sources of Pollution of the Lakhya river (Source: WSP, 1998)

Source	Description	Drain into
Majheepara Khal, Killarpul Khal, Kalibazar Khal, Tanbazar Khal, B. K. Road Khal	Carry untreated wastewater originating from domestic and industrial sources in the Narayanganj City.	Lakhaya River
DND Khal	DND Khal carries domestic and industrial wastewaters from the DND project area	Lakhaya River

Point Sources of Pollution of the Balu river: The major point source of pollution to the Balu river is Norai Khal. The Norai Khal carries wastewater from a number of wastewater khals such as Begunbari Khal and Rampura Khal. These khals carry domestic and industrial wastewaters including effluent from Tejgaon Industrial Area.

Point Sources of Pollution of the Tongi Khal: The major sources of pollution in the Tongi Khal are industries. However, before entering into the khal, wastewaters from many of the industries get compounded with domestic waste.

2.7.2 Non-point Sources of Pollution

There are numerous indistinct sources, which discharge pollutants in the peripheral rivers around Greater Dhaka. They are either of domestic origin or of industrial origin. Some are combined wastes from domestic and industrial sources.

Table 2.8 Non Point Sources of Pollution (Source: WSP, 1998)

Source	Description	Drain into
Lalbag to Babubazar, (Islambagh, Shahidnagar, Rasulpur and Kamrangirchar)	Beyond Babubazar Wastewater mainly of domestic origin is released through 40 drains.	Buriganga River
Zinzira and Keraniganj	Wastewater of combined origin discharged from densely populated area	Buriganga
Jurain, Pagla, Fatulla and Shyambazar	Contribute pollutants of domestic and industrial origin. Wastewater of Fatulla and Shyambazar is mainly of industrial origin	Buriganga River
Narayanganj City	Wastewater discharge from domestic and industrial activities	Lakhya River

2.7.3 Pollution Loads Discharged into the River System

Points sources of pollution are definite and their contributing loads can be computed both by Wet and Dry methods. Loads added by non-point sources also can be estimated by dry method. Pollution loads discharged into the different river reaches estimated for 1998 are as shown in Table 2.9.

Table 2.9 Pollution loads discharged into the river system (WSP, 1998)

Name of Outfalls	Discharge into	Pollution Load (kg/d)					
		BOD_5	NH_3-N	PO_4-P	Cr	Pb	Zn
Sluice No. S-3	Tongi K	700	20	2	1	1.5	80
Sluice No. S-4	Turag	2900	350	60	1	2.5	80
Sluice No. S-5	Turag	990	115	35	0.25	1	4
Sluice No. S-6	Turag	6800	600	150	2.5	6	50
Sluice No. S-7	Turag	24200	3800	500	750	10	150
Sluice No. S-8	Buriganga	1300	100	30	0.6	0.25	5
Sluice No. S-9	Buriganga	6000	1000	250	0.8	2.5	45
Sluice No. S-10	Buriganga	3800	300	100	0.9	1	30
Dholai Khal	Buriganga	30000	3100	1050	6	9	140
Pagla STP	Buriganga	9000	425	650	4	2	200
Majheepara K	Lakhya	1350	40	10	0.1	0.3	9
Killarpul K	Lakhya	850	100	35	0.1	0.3	10
Tanbazar K	Lakhya	1300	230	75	0.2	0.2	3
B. K. Road K	Lakhya	50	30	15	0.01	0.04	0.6
DND K	Lakhya	14325	690	350	7	4	325
Kalibazar K	Lakhya	1250	250	80	0.1	0.2	10
Norai K	Balu	75300	7700	2200	8	40	1000
Kashipur K	Dhaleswari	30000	870	500	3	30	45
City Drains	Buriganga	8000	840	250	5	3.5	100
Lakhaya L/B	Lakhya	4150	430	140	1	1.5	48
Tongi	Tongi K	5160	540	170	1.5	2	60
Dhaleswari L/B	Dhaleswari	2800	290	100	0.5	0.9	32

DATA COLLECTION

3.1 General

Measurement of water quality is very expensive, requires skilled manpower, sophisticated instruments and well organized laboratory facilities. As a government organization, Department of Environment (DOE) measures some specific water quality parameters at some selected locations in the peripheral rivers around the Dhaka city (Table 3.1) which include DO, BOD_5 (at 20 ^{0}C), COD, turbidity, pH, Electrical conductivity, alkalinity, temperature, solids and Coliforms (T.C. and F.C.). Besides, some water quality parameters had been measured during study of "Forth Dhaka Water Supply Project". Institute of Water Modelling had carried out a water quality assessment program from April' 2003 to April' 2004 for its research purpose at the locations identified during the study of "Forth Dhaka Water Supply Project", as shown in Table 3.2 (stream water observation) and Table 3.3 (wastewater observation). The measured water quality parameters include DO, BOD_5 (at 20 ^{0}C), COD (dichromate value), NH_3-N, NH_4-N, NO_3-N, PO_4, chromium (Cr), lead (Pb), mercury (Hg), zinc (Zn) and colliform (T.C. and F.C.). The water quality measurement stations in the peripheral rivers around the Dhaka and Narayanganj city have been shown in Figure 3.1 and 3.2.

Table 3.1 Water quality monitoring stations of Department of Environment (DOE) in the peripheral rivers around the Dhaka city

Sample Type	Station	River	Data Availability
River Water	Estama Ghat	Tongi Khal	2002
River Water	Mirpur Bridge	Turag	2000 to 2003
River Water	Hazaribag	Buriganga	1980 to 2003
River Water	Kamrangir Char	Buriganga	2000 to 2003
River Water	Chandighat	Buriganga	1984 to 2003
River Water	Sadarghat	Buriganga	2000 to 2003
River Water	Farashganj	Buriganga	2000 to 2003
River Water	Dholai Khal	Buriganga	2000 to 2003
River Water	Bangladesh China Bridge	Buriganga	2000 to 2003
River Water	Pagla	Buriganga	1988 to 2003
River Water	Demra Ghat	Lakhya	2002, 2003
River Water	Ghorashal	Lakhya	2002, 2003
Waste Water	Ghorashal	Drain	2002, 2003
River Water	Narayanganj (ACI)	Lakhya	2002, 2003
Waste Water	Narayanganj (ACI) Drain	Lakhya	2002, 2003
River Water	Bengal Indigo	Balu	2002
Waste Water	Hazaribag	Main Drain	1980 to 1994
Waste Water	Pagla STP	Main Drain	1988 to 1993

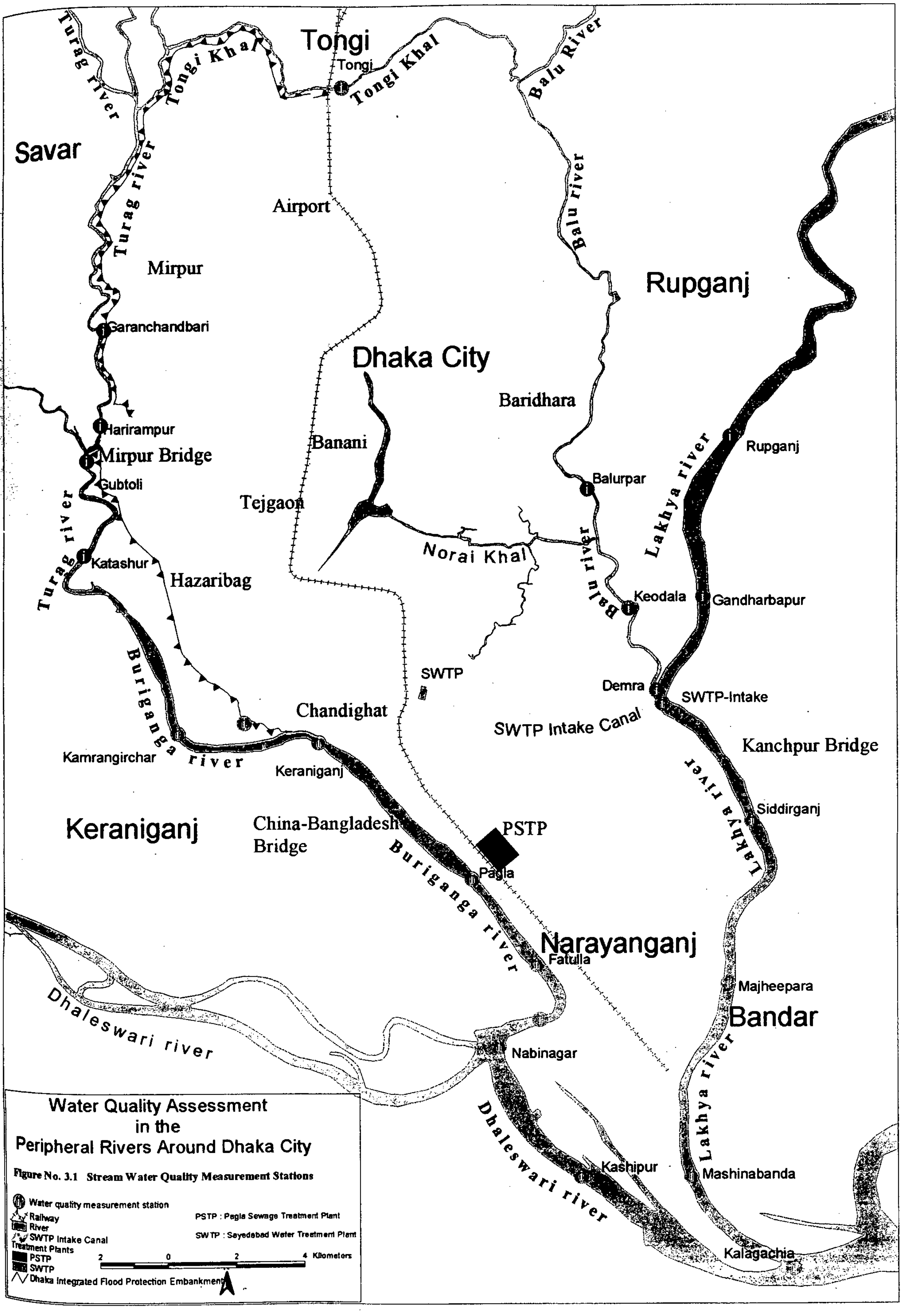


Figure No. 3.1 Stream Water Quality Measurement Stations

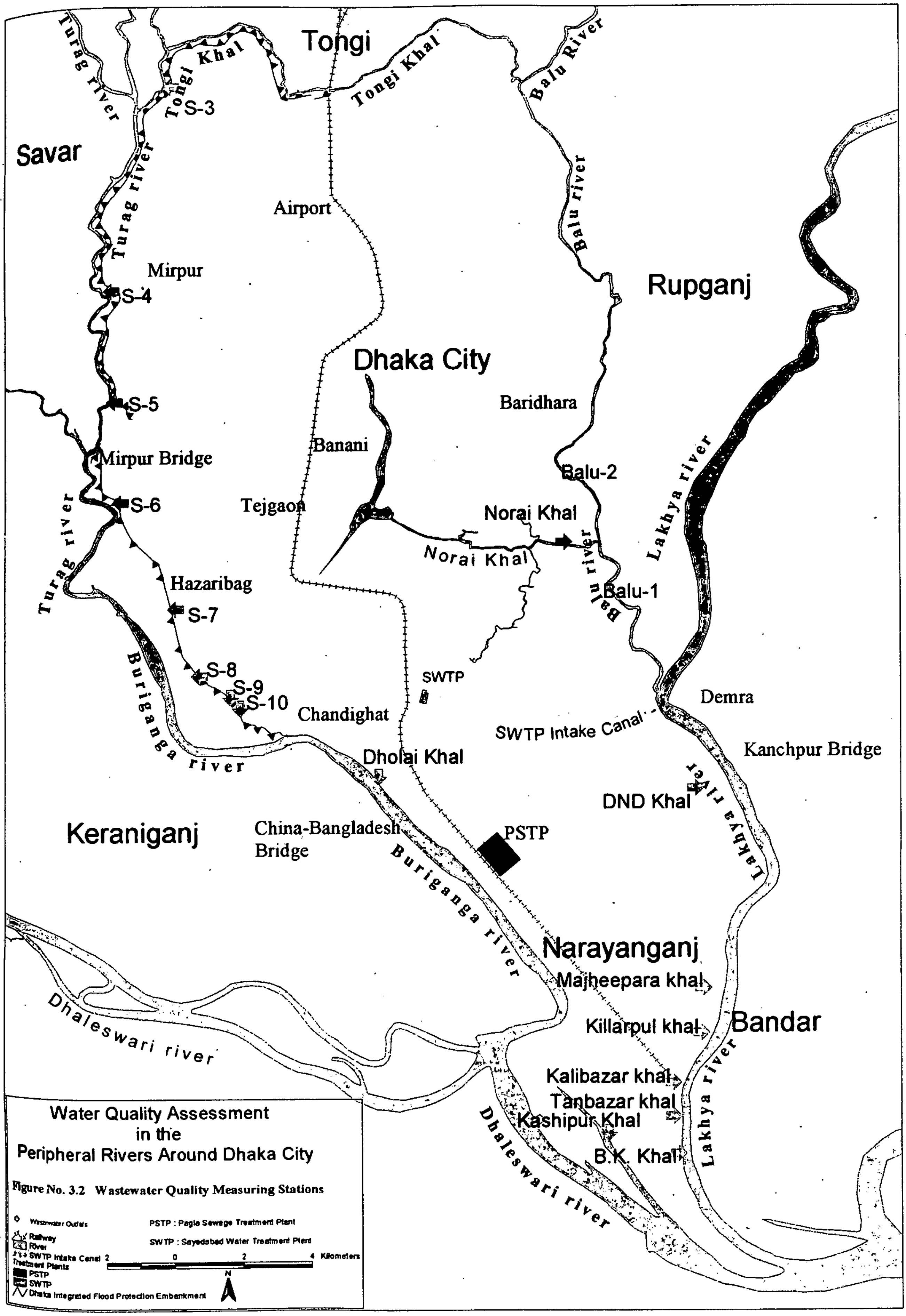


Figure No. 3.2 Wastewater Quality Measuring Stations

Table 3.2 Water quality sampling stations of Institute of Water Modelling (IWM) in the peripheral river system around the Dhaka city

SampleType	Station ID	Location	Name of River	Observations
River Water	Turag-2	Mirpur	Turag	Dec'97, Jan'98, Feb'98, Apr'03, Dec'03, Mar'04 and Apr'04
River Water	Turag-1	U/S of Mirpur Bridge	Turag	
River Water	Buri-1	D/S of Mirpur Bridge	Turag	
River Water	Buri-2	Bashila	Turag	
River Water	Buri-3	Islampur	Buriganga	
River Water	Buri-4	Islampur	Buriganga	
River Water	Buri-5	Chandighat	Buriganga	
River Water	Buri-6,	Pagla	Buriganga	
River Water	Buri-7	Fatulla	Buriganga	
River Water	Buri-8	Hariharpara	Buriganga	
River Water	Buri-9	Nabinagar	Dhaleswari	
River Water	Buri-10	Rekabibazar	Dhaleswari	
River Water	Buri-11	Kalagachia	Dhaleswari	
River Water	Lakh-1	B.K Road	Lakhya	
River Water	Lakh-1a	Pathantali	Lakhya	
River Water	Lakh-2	Siddirganj	Lakhya	
River Water	Lakh-2a	Sarulia	Lakhya	
River Water	Lakh-3	Demra	Lakhya	
River Water	Lakh-4	Gandharbapur	Lakhya	
River Water	Lakh-5	Rupganj	Lakhya	
River Water	Balu-1	Keodala	Balu	
River Water	Balu-2	Balurpar	Balu	

Table 3.3 Water quality sampling stations of Institute of Water Modelling (IWM) located in wastewater outlets of the Dhaka and Narayanganj city

SampleType	Name of Outlet	Location	Contribute to the River	Observations
Waste Water	S-3		Tongi Khal	Dec'97, Jan'98, Feb'98, Apr'03, Dec'03, Mar'04 and Apr'04
Waste Water	S-4		Turag	
Waste Water	S-5	Mirpur	Turag	
Waste Water	S-6	Mohammadpur	Turag	
Waste Water	S-7	Katashur	Turag	
Waste Water	S-8	Hazaribag	Buriganga	
Waste Water	S-9	Islampur	Buriganga	
Waste Water	S-10	Lalbag	Buriganga	
Waste Water	S-11		Buriganga	
Waste Water	Dholai Khal	Millbarak	Buriganga	Dec'97, Jan'98, Feb'98, Feb'04, Mar'04 and Apr'04
Waste Water	PSTP Outfall	PSTP	Buriganga	
Waste Water	Norai Khal	Demra	Balu	
Waste Water	Majeepara Khal	Majeepara	Lakhya	
Waste Water	Killarpul Khal	Killarpul	Lakhya	
Waste Water	Kalibazar Khal	Kalibazar	Lakhya	
Waste Water	Tanbazar Khal	Tanbazar	Lakhya	
Waste Water	B.K. Road Khal	B.K Road	Lakhya	
Waste Water	Kashipur Khal	Kashipur	Dhaleswari	

3.2 Water Quality Data Collected from Department of Environment (DOE)

Historical water quality data at Hazaribag, Chandni Ghat and Pagla measured by DOE from 1980 to 1994 have been collected from Kamal, (1996). Measured parameters include pH, chloride, alkalinity, total suspended solid (TSS), DO, BOD_5 at 20^0C, COD, NH_3-N, Coliform and Chromium. Only limited data of the last four parameters were available. Recent data at locations specified in Table 3.1 measured by DOE from 2000 to 2003 has been collected from a Study report of the Buriganga river (IWM, 2004) which include data on turbidity, temp, DO, BOD_5 (at 20 ^0C), COD, pH, EC and alkalinity. Only limited data on COD data was available. All data collected from DOE have been tabulated in Table A.1 to Table A.5 in Appendix-A.

3.3 Water Quality Data Collected from Institute of Water Modelling (IWM)

Institute of Water Modelling (IWM) measured water quality at the locations specified in Table 3.2 and 3.3 during December 1997, January 1998 and February 1998 in connection with the " Fourth Dhaka Water Supply Project" in the peripheral river system as well as in the wastewater outlets. Measured parameters include BOD_5, NH_3, NO_3^-, PO_4^{3-}, Cr, Pb, Zn and coliform. The institute also measured water quality during Apr'03, Dec'03, Mar'04 and Apr'04, which included DO, BOD_5, COD, NH_3-N, NH_4^+-N, NO_3^--N, PO_4^{---}, chromium (Cr), mercury (Hg) and lead (Pb). All data collected from IWM have been shown in Table A.6 in Appendix-A.

ANALYSIS OF WTER QUALITY AND POLLUTION LOADS

4.1 General

The water quality in a river system is closely related with its hydraulics, storage volume and pollution loads. Therefore, a brief overview of hydrometrics and topography has been included before analysis of water quality. The analysis includes both stream water quality and wastewater quality. The later is only for estimation of pollution loads discharged into the system. This chapter illustrates elaborately the consistency of data, present water quality scenario in the river system as well as pollution loads discharged into them. Attempt has been taken to establish historical trend in spite of limited data quantity. Interrelationship among the parameters has been scrutinized as far as possible. Stream water quality has been illustrated in the light of different guideline values (e.g. USEPA, WHO and Bangladesh) for drinking standard to identify environmentally safe river reaches. Profiles of different water quality parameters have been drawn along the entire river system for providing an indication of pollution status. Historical trend of water quality has been evaluated at three locations in the Buriganga River. Ratio of BOD to COD has been computed for assessment of the characteristics of pollution. Pollutions loads discharged into the river system has been computed and compared with previous estimations.

4.2 River System, Hydrometrics and Storage Volume

The river system surrounding the Dhaka city comprises a length of about 111.00 km. The river reaches include the Turag river (18500 m), the Buriganga river (21500 m), the Dhaleswari river (12100 m), the Lakhya river (20600 m), the Balu river (22200 m) and the Tongi Khal (15800 m).

The water level in the river system varies from 1 m PWD to 1.50 m PWD having an average level 1.35 m PWD (Figure 4.1) during dry period. The river system gets virtually no fresh water inflows from upstream except some wastewaters and agricultural returned water in the dry season.

Average channel widths at level of 1.5 m PWD are 150 m, 300 m, 700 m, 60 m, 55 m, and 260 m of Turag river, Buriganga river, Dhaleswari river, Tongi Khal, Balu river and Lakhya river, respectively. The interrelations among elevation, open channel area and storage volume are as shown in Figure 4.2. Storage volume and open area of the river system at 1.25 m PWD level (an average water level in dry season) are 75 million m^3 and 32 million m^2, respectively.

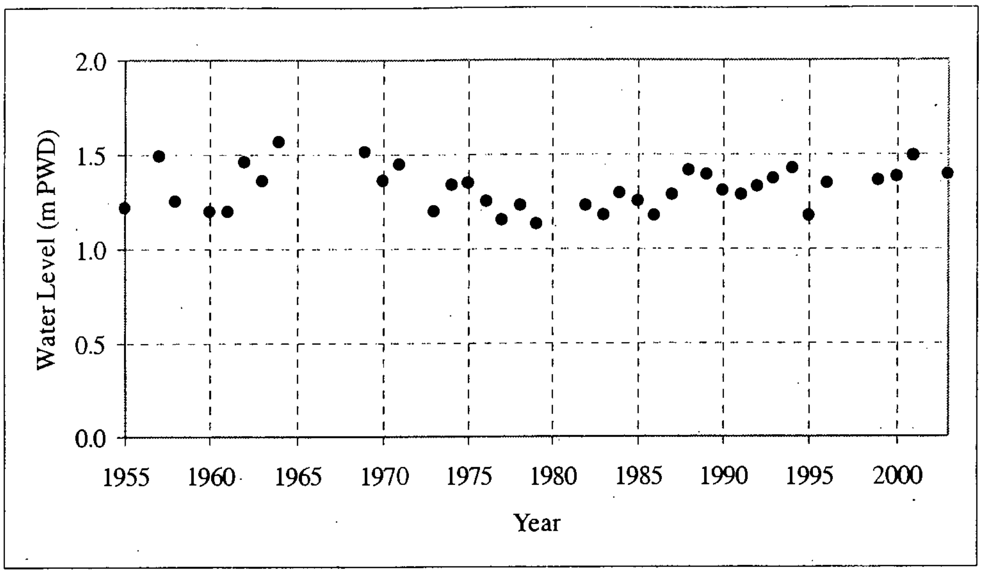


Figure 4.1 Average water level of February at Mirpur in the Turag River

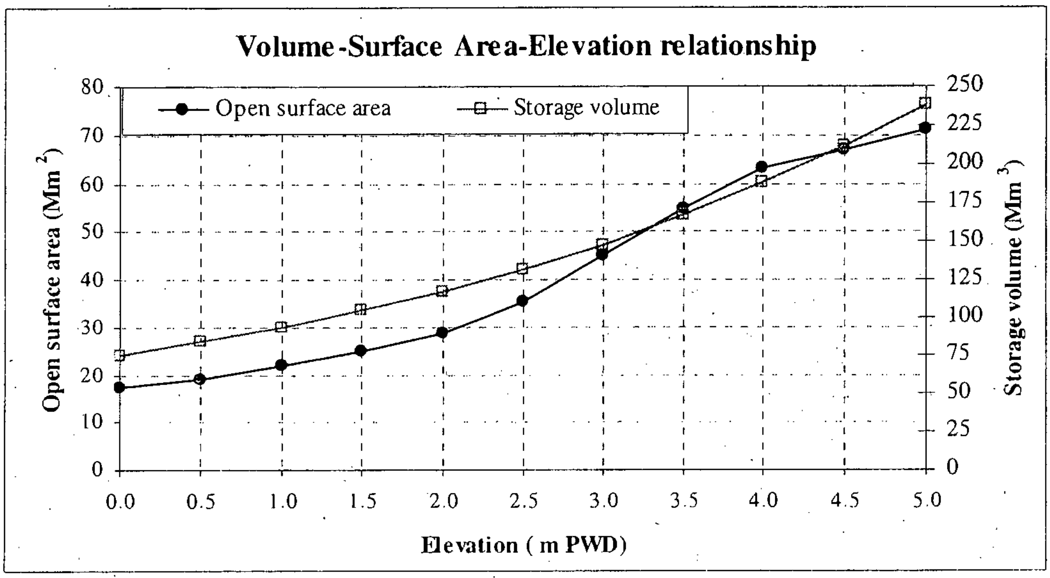


Figure 4.2 Relations of open surface area, storage volume and elevation in the peripheral river system around the Dhaka city

4.3 Stream Water Quality

Stream water quality has been assessed keeping attention on the drinking standard as well as sustainability of aquatic lives. Although the analysis has iterated the term peripheral rivers of Dhaka city innumerable times, there are very few data of the river reaches located in the north i.e. Tongi Khal. The inflow and outflow of Tongi Khal is completely controlled by Turag and Balu river. Therefore, the term peripheral rivers is justified in the sense that water quality of the Tongi Khal would not be superior to, rather equivalent to or worse than that of the Turag and Balu river. Water quality observed in different measurements in the river system has been illustrated in the following articles.

4.3.1 Dissolved Oxygen (DO)

Dissolved oxygen content has been pointed up through diurnal variation, seasonal variation, minimum concentration levels and consistency with respect to source, sink and controlling parameters. Historical trend has been tried to evaluate in spite of insufficient data.

Diurnal Variation of Dissolved Oxygen

Dissolved oxygen has been plotted at each station with respect to time for evaluation of diurnal variation and has been shown in Figure B.1.1 to Figure B.1.18 in Appendix-B. A complete diurnal variation is not conceived since DO had been measured only from 9:00 am to 4:00 pm in most of the campaigns. There is almost no diurnal variation of DO in the Buriganga river (Figure 4.3). Insignificant diurnal variation of DO is observed in the Turag river as well as Lakhya river (Figure 4.4 and 4.5, respectively). Diurnal variation of DO is observed frequently in the Balu river (Figure 4.6). Significant diurnal variation of DO in the observation tenure is present in the Dhaleswari river (Figure 4.7).

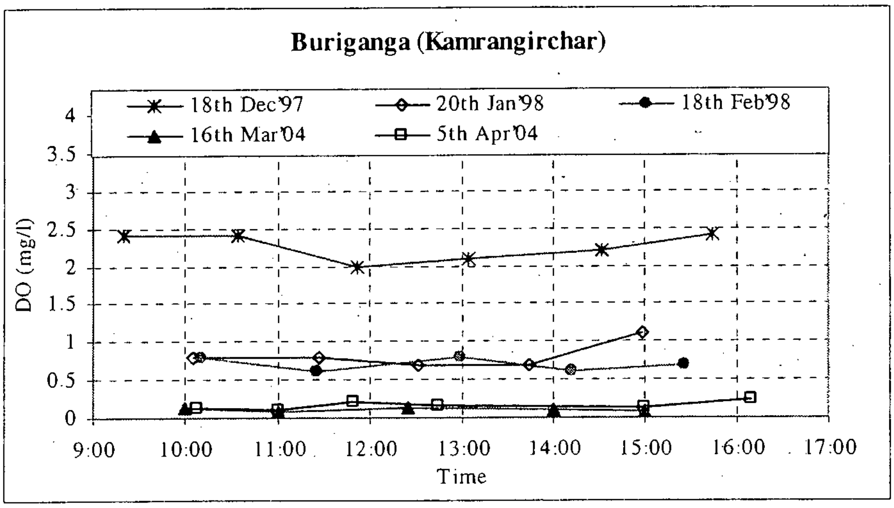


Figure 4.3 Diurnal variation of DO in the Buriganga river at Kamrangirchar
(Data source: IWM, 2005)

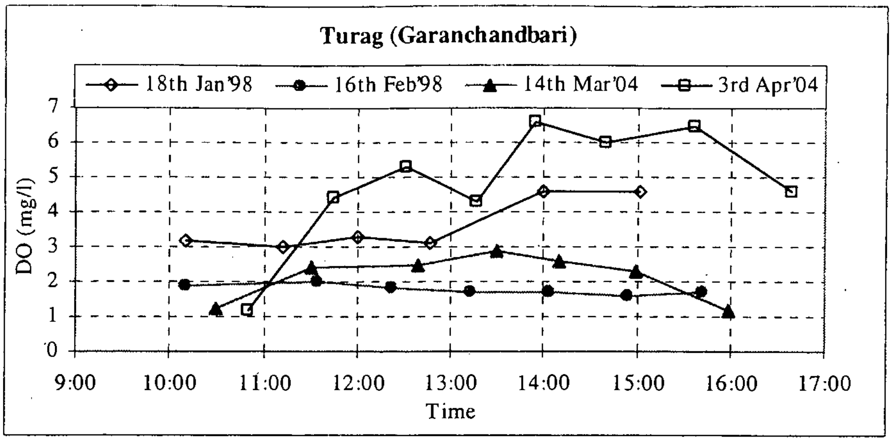


Figure 4.4 Diurnal variation of DO in the Turag river at Garanchandbari (Data source: IWM, 2005)

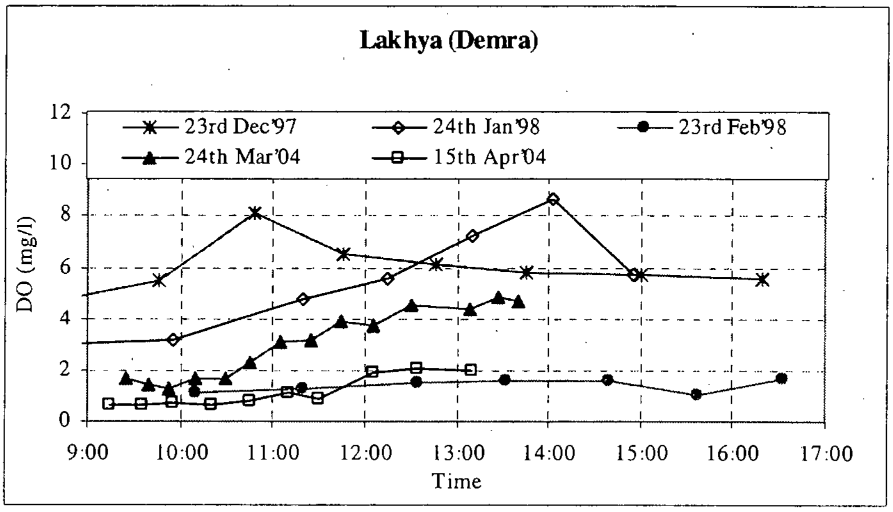


Figure 4.5 Diurnal variation of DO in the Lakhaya river at Demra (Data source: IWM, 2005)

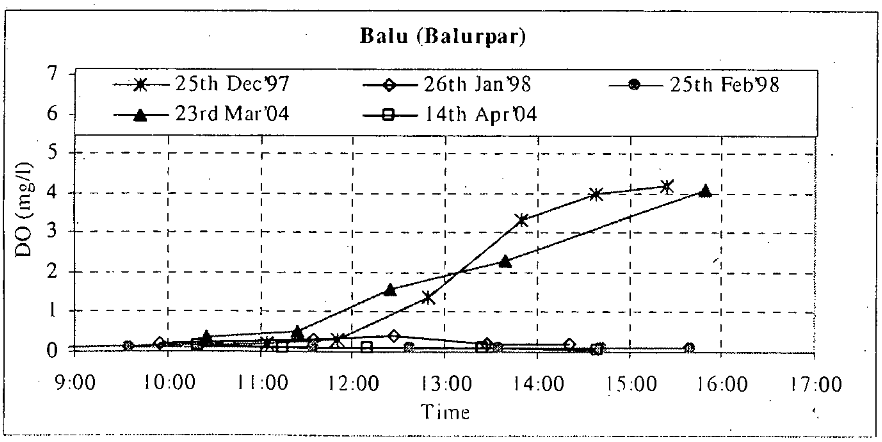


Figure 4.6 Diurnal variation of DO in the Balu river at Balurpar (Data source: IWM, 2005)

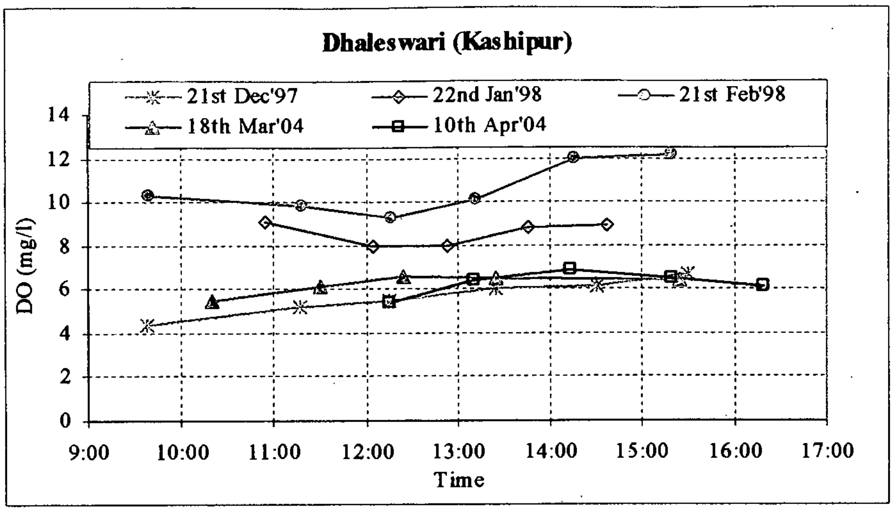


Figure 4.7 Diurnal variation of DO in the Dhaleswari river at Kashipur (Data source: IWM, 2005)

Seasonal Variation of Dissolved Oxygen

Dissolved oxygen concentration remains low in the dry seasons (i.e. January, February, March and April) and it maintains the level more than 5 mg/l (required for sustaining aquatic habitats) from May to December in the entire peripheral river system. Variation of DO through all the year round during 2002 has been plotted in Figure 4.8. Observations of 2002 show relatively high DO content during dry periods in the Lakhya river which is not reflected in the recent measurements. The recent scenario is worse than that of 2002.

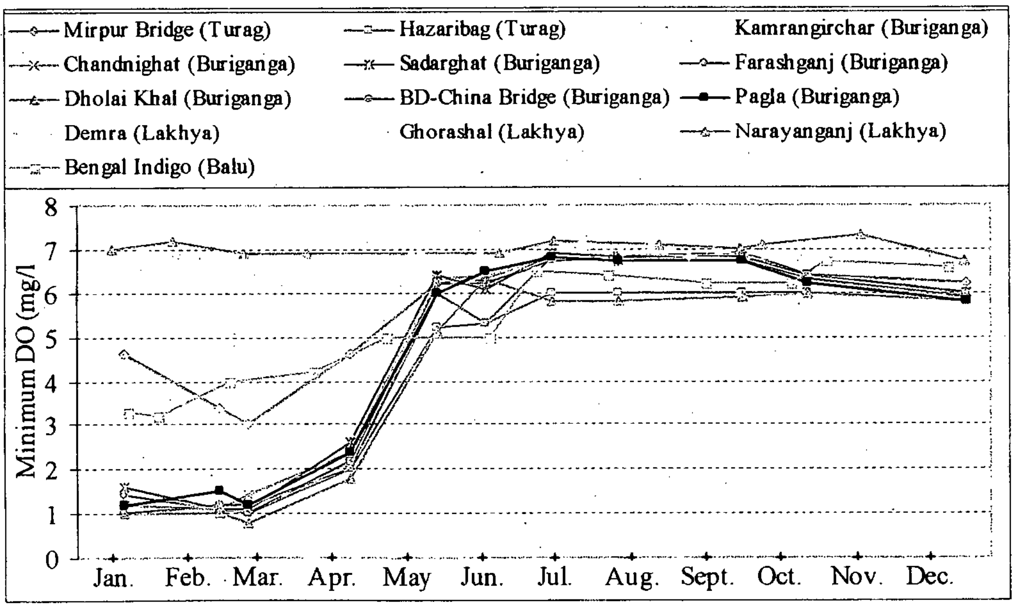


Figure 4.8 Seasonal variation of DO in the peripheral rivers observed in 2002 (Data source: IWM, August 2004)

Minimum Dissolved Oxygen Content

Apparent maximum and minimum DO can be estimated from the available measurements. For detail analysis, minimum value of the measured DO data has been regarded as the "daily minimum DO". The exact daily minimum DO that actually occurs may be petite lower than that computed from measured values since it does not comprise the records observed at night and in the early morning. Minimum dissolve oxygen profiles of the entire river system at different measurements have been drawn and shown in Figure B.2.1 to B.2.9 in Appendix-B. Dissolved oxygen contents observed during Mar'04 and Apr'04 have been shown in Figure 4.9.

An interesting interrelation among Temperature, DO and BOD is observed from the measured data during Mar'04 and Apr'04 (Figure 4.9 and 4.10, respectively). There are no significant changes of DO at Garanchandbari, Harirampur, Gubtoli, Katashur, Kamrangir Char, Keraniganj and Kashipur although there was higher BOD (on an average 10 mg/l) during Mar'04. The higher oxygen demand has been balanced from reduced temperature. Lower temperature in March (around 2 ^{0}C) increased the oxygen replenishment and reduced oxygen consumption through biological degradation. Higher DO at Pagla, Fatulla, Nabinagar, Gandharbapur and Rupganj during April is due to reduced BOD load. Lower DO during April at Kalagachia and Mosinabanda resulted from higher temperature and a little increased BOD. Dissolve oxygen reduced at Pathantali, Siddhirganj, Keodala and Balurpar due to higher BOD load and temperature.

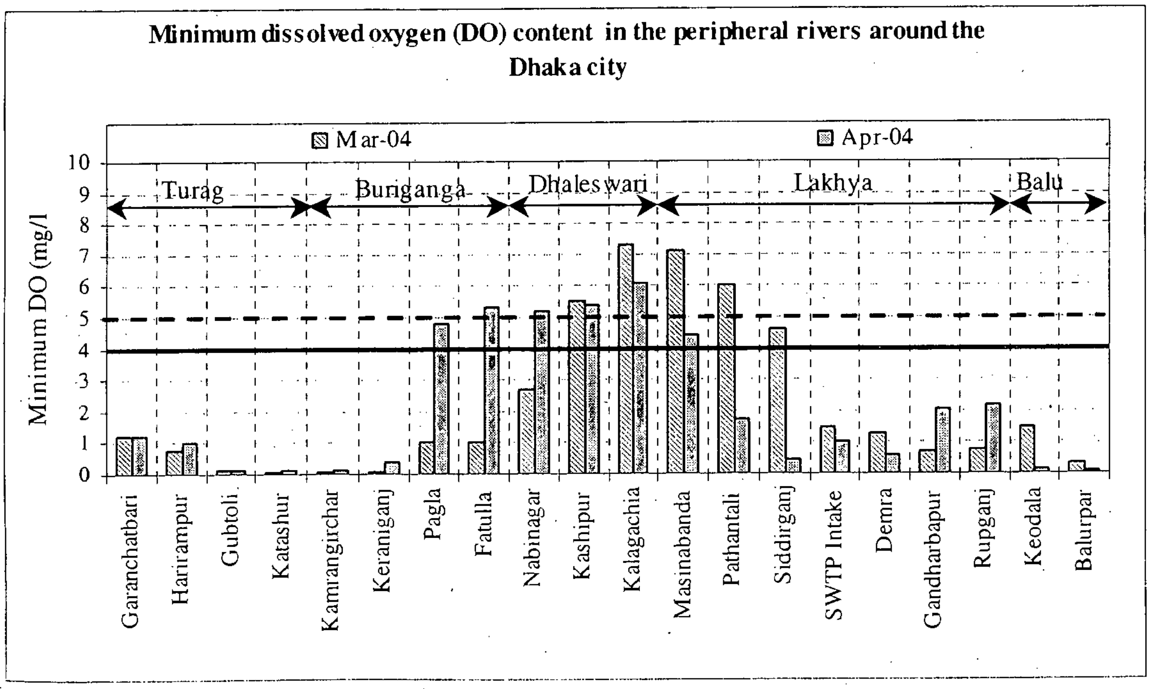


Figure 4.9 Minimum dissolved oxygen content in the peripheral rivers system of Mar'04 and Apr'04 (Data source: IWM, 2005)

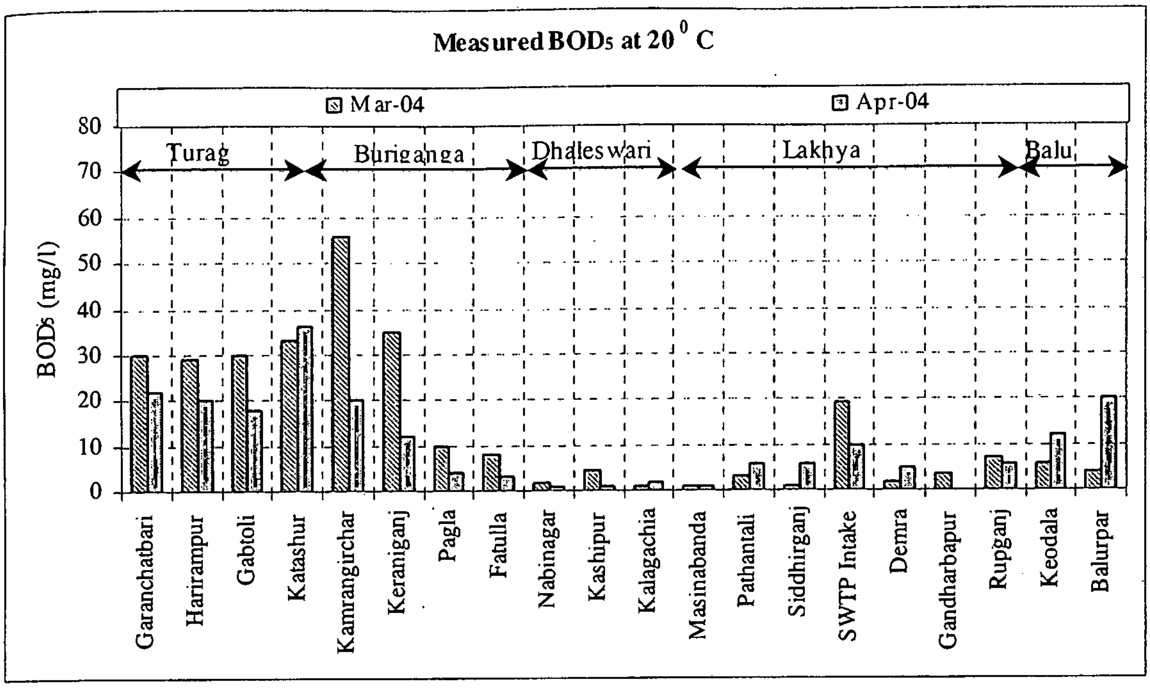
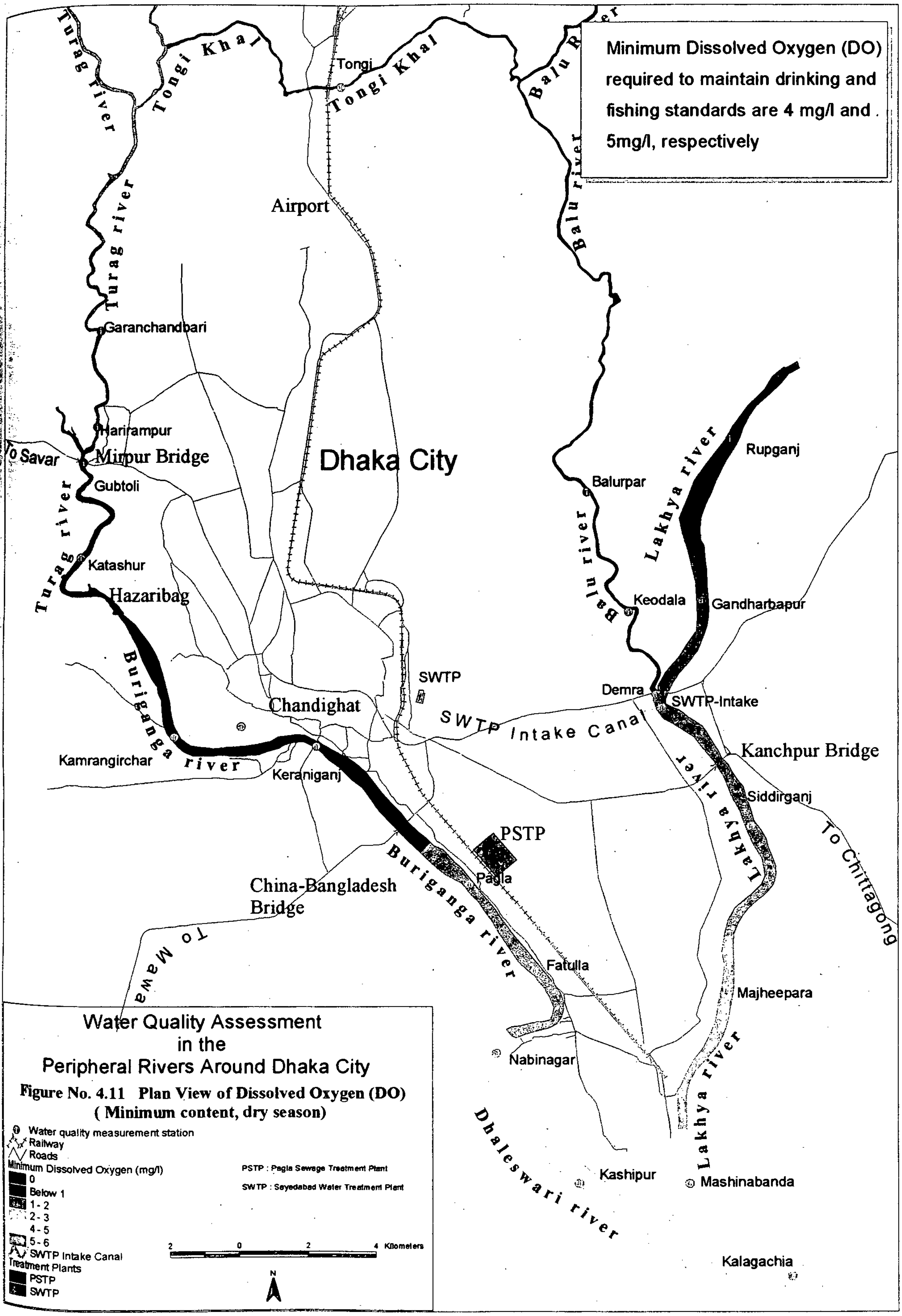


Figure 4.10 Measured BOD_5 (at 20 ^{0}C) in the peripheral river system on Mar'04 and Apr'04 (Data source: IWM, 2005)

Minimum dissolved oxygen contents recorded in different reaches of the river system during last two campaigns (March and April 2004) are as follows:

River / Khal reach	**Minimum DO (mg/l)**
Turag river	below 1.0
Buriganga river (Hazaribag to Keraniganj)	nearly 0
Buriganga river (Keraniganj to Fatulla)	below 1.0
Dhaleswari river (Fatulla to Nabinagar)	around 2.0
Dhaleswari river (Kashipur to Kalagachia)	above 5.0
Lakhya river (Kalagachia to Mosinabanda)	above 4.0
Lakhya river (Siddhirganj to Rupganj)	below 1.0
Balu river	below 1.0
Tongi Khal	below 1.0

The minimum dissolved oxygen contents required for maintaining standards of drinking, fishing, recreation and agriculture are 4, 5, 4 and 5 mg/l, respectively. The plan view of minimum dissolved oxygen content in different river reaches has been depicted in Figure 4.11.



Water Quality Assessment in the Peripheral Rivers Around Dhaka City

Figure No. 4.11 Plan View of Dissolved Oxygen (DO) (Minimum content, dry season)

Historical Trend of Dissolved Oxygen

Profiles of minimum dissolved oxygen contents of 8 measurements along the peripheral river system especially during dry season observed since Dec'1994 have been plotted in Figure 4.12. It is found that minimum DO level reaches to almost zero in the Turag river, Buriganga river and Balu river. Random variation of DO is observed in the Dhaleswari river and Lakhya river. DO level of the former three rivers is strongly influenced by BOD load where as both BOD and tidal fluctuation control DO in the latter two river reaches.

Minimum dissolved oxygen concentrations at Mirpur Bridge, Kamrangirchar, Nabinagar, Siddhirganj and Balurpar on the Turag river, Buriganga river, Dhaleswari river, Lakhya river and Balu river, respectively have been plotted in Figure 4.13. Gradual depletion of dissolved oxygen is observed in the Buriganga river. Minimum dissolved oxygen in the dry period reaches nearly zero in the Balu river since 1997. The Turag river shows gradual falling except Dec'97 and Jan'98. The relatively high DO in the Turag river during Dec'97 and Jan'98 probably occurred due to error in measurement. The sudden increase of DO (measured on 20th March, 2004) in the Lakhya river was happened due to dilution resulting from early rainfall. The rainfall increased storage volume and river flows (Figure 4.14) resulting a reduced biological oxygen demand.

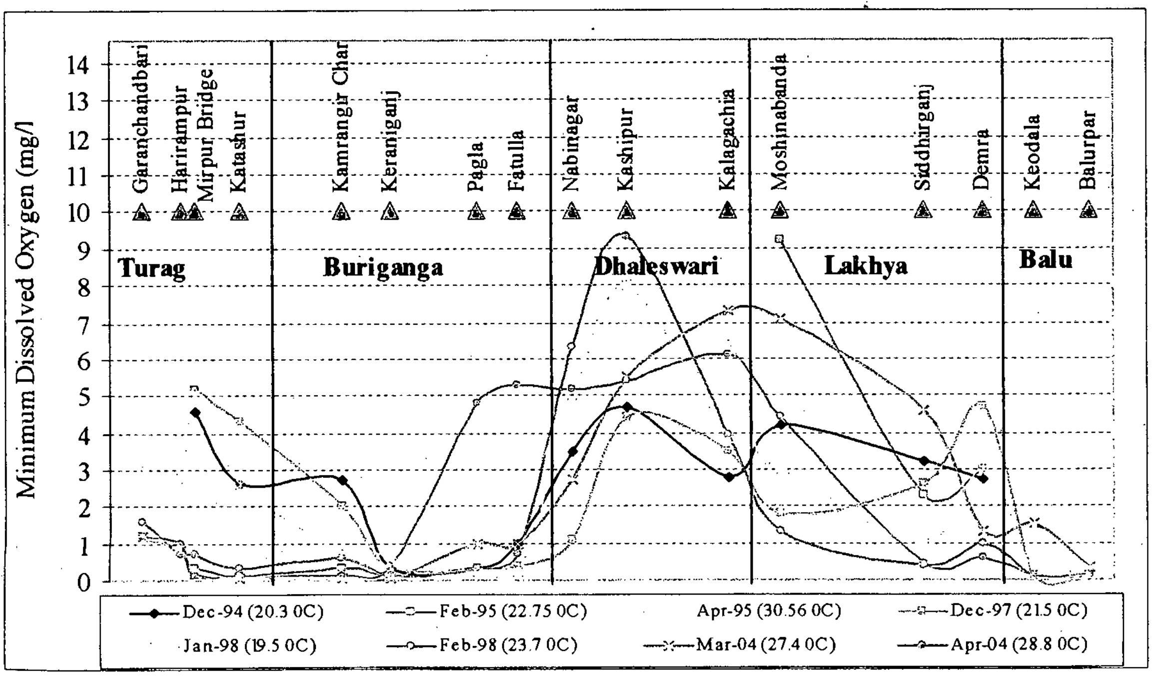


Figure 4.12 Profile of minimum dissolved oxygen content along the peripheral rivers (Data Source: Kamal, 1996; WSP International, 1998; IWM, 2005)

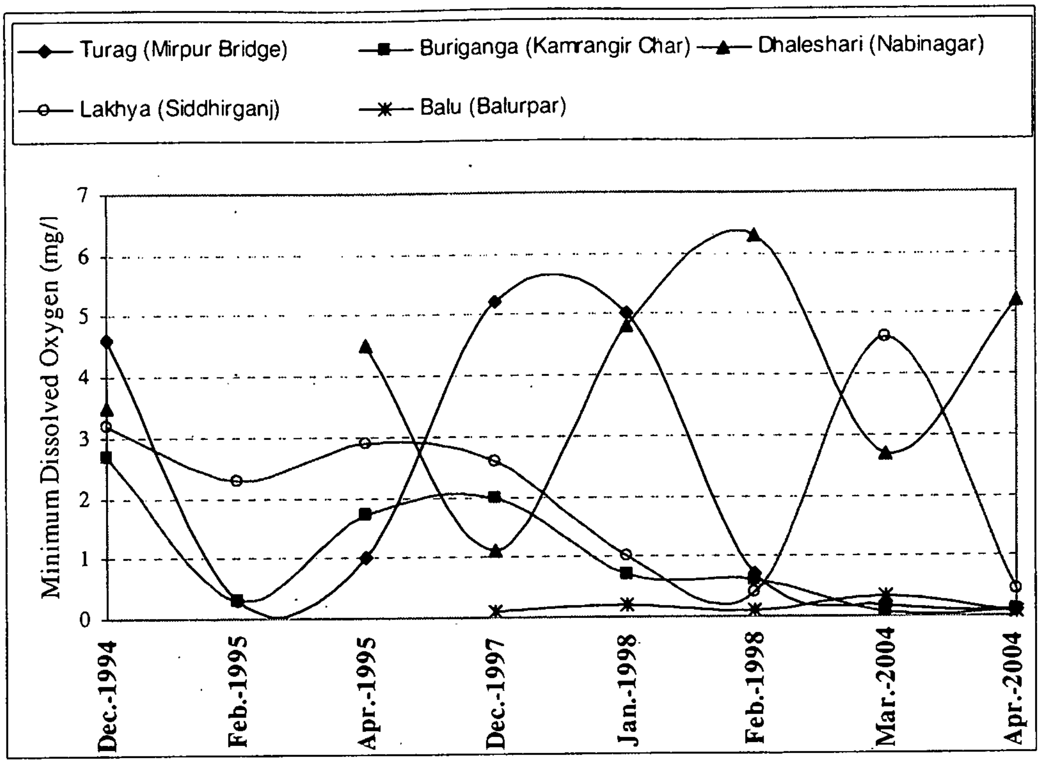


Figure 4.13 Historical trend of minimum dissolved oxygen contents at some locations in the peripheral river system around the Dhaka City (Data Source: Kamal, 1996; WSP International, 1998; IWM, 2005)

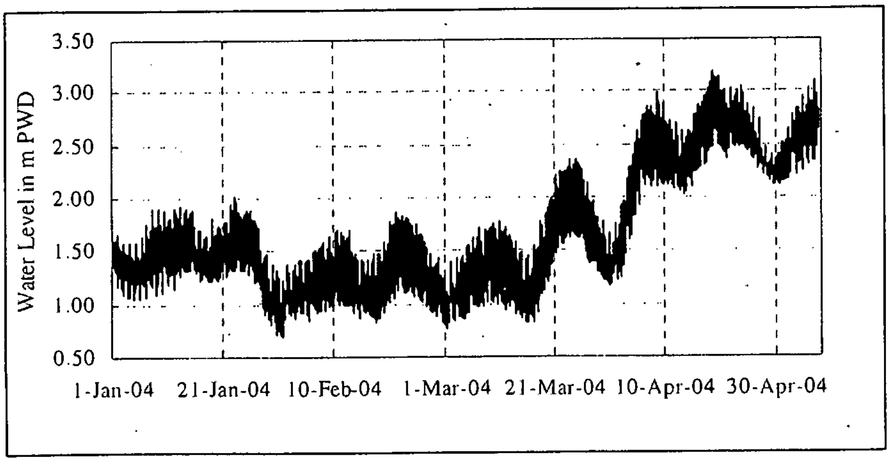


Figure 4.14 Measured water level at Kalagachia on the Dhaleswari river showing early pre-monsoon rainfall on March and April 2004 (Data Source: IWM, 2005)

4.3.2 Biochemical Oxygen Demand (BOD)

Present Scenario

Measured biochemical oxygen demand (BOD_5 at 20 ^{0}C) during Dec'97, Jan'98, Feb'98, Apr'03, Dec'03, Mar'04 and Apr'04 in the river system has been possible to be procured. Profiles of BOD_5 at 20 ^{0}C during different campaign have been plotted in Figure C.1 to Figure C.7 in Appendix-C. BOD_5 (at 20 ^{0}C) is quite high (varying from 5 mg/l to 40 mg/l) in the Turag River. The high BOD generally occurs at Kamrangirchar in the Buriganga river. BOD hardly crosses 10 mg/l in the Dhaleswari and Lakhya river. In the Balu river, BOD varies from 5 mg/l to 70 mg/l. BOD measured during Mar'04 and Apr'04 is relatively low due to dilution resulting from early pre-monsoon rainfall. Profile of maximum BOD_5 at 20 ^{0}C of the recent available records (during Apr'03, Dec'03, Mar'04 and Apr'04) has been shown in Figure 4.15. It is crucial to point out that the recent measurements does not comprise records of February usually when the BOD reaches to maximum level. Therefore, maximum BOD that the river system really experiences may be petite higher than that have been shown.

It is observed that BOD at Sarulia in the Lakhya river is higher than that measured in both upstream (Demra, upstream of the confluence of Balu river) and downstream (Siddhirganj) reaches. It is resulted due to drain out of wastewater through Norai Khal and DND Khal into the Balu and Lakhya river, respectively.

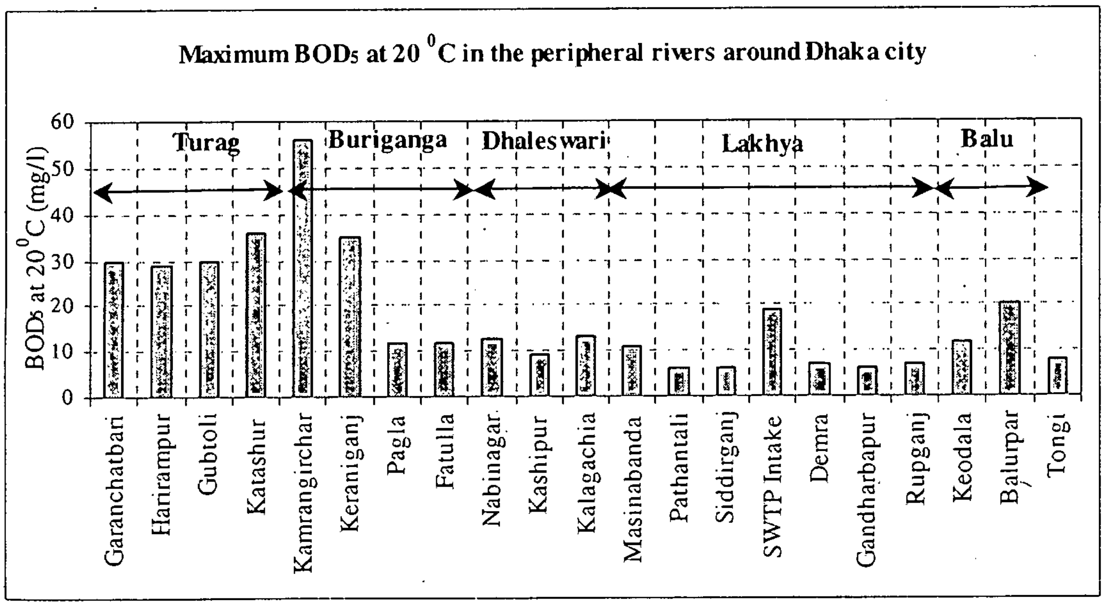


Figure 4.15 Profile of maximum Biochemical Oxygen Demand (BOD_5 at 20 ^{0}C) along the peripheral river system around the Dhaka city (Measurements: Apr'03, Dec'03, Mar'04 and Apr'04) (Data Source: IWM, 2005)

Maximum BOD_5 (at 20 ^{0}C) in the rivers system observed during the last two dry seasons (Apr'03, Dec'03, Mar'04 and Apr'04) can be summarized as follows:

River / Khal reach	Maximum BOD_5 at 20 ^{0}C (mg/l)
Turag river	around 30
Buriganga river (Hazaribag to Keraniganj)	35 to 55
Buriganga river (Keraniganj to Fatulla)	around 12
Dhaleswari river	around 12
Lakhya river (Mosinabanda to Demra)	around 10
Lakhya river (Demra to Rupganj)	around 7
Balu river	12 to 20
Tongi Khal	around 08

Maximum allowable BOD for drinking, fishing, recreational and agricultural standards are 3, 6, 3 and 10 mg/l, respectively. The plan view of maximum biological oxygen demand (BOD_5 at 20 ^{0} C) in the river system has been depicted in Figure 4.16.

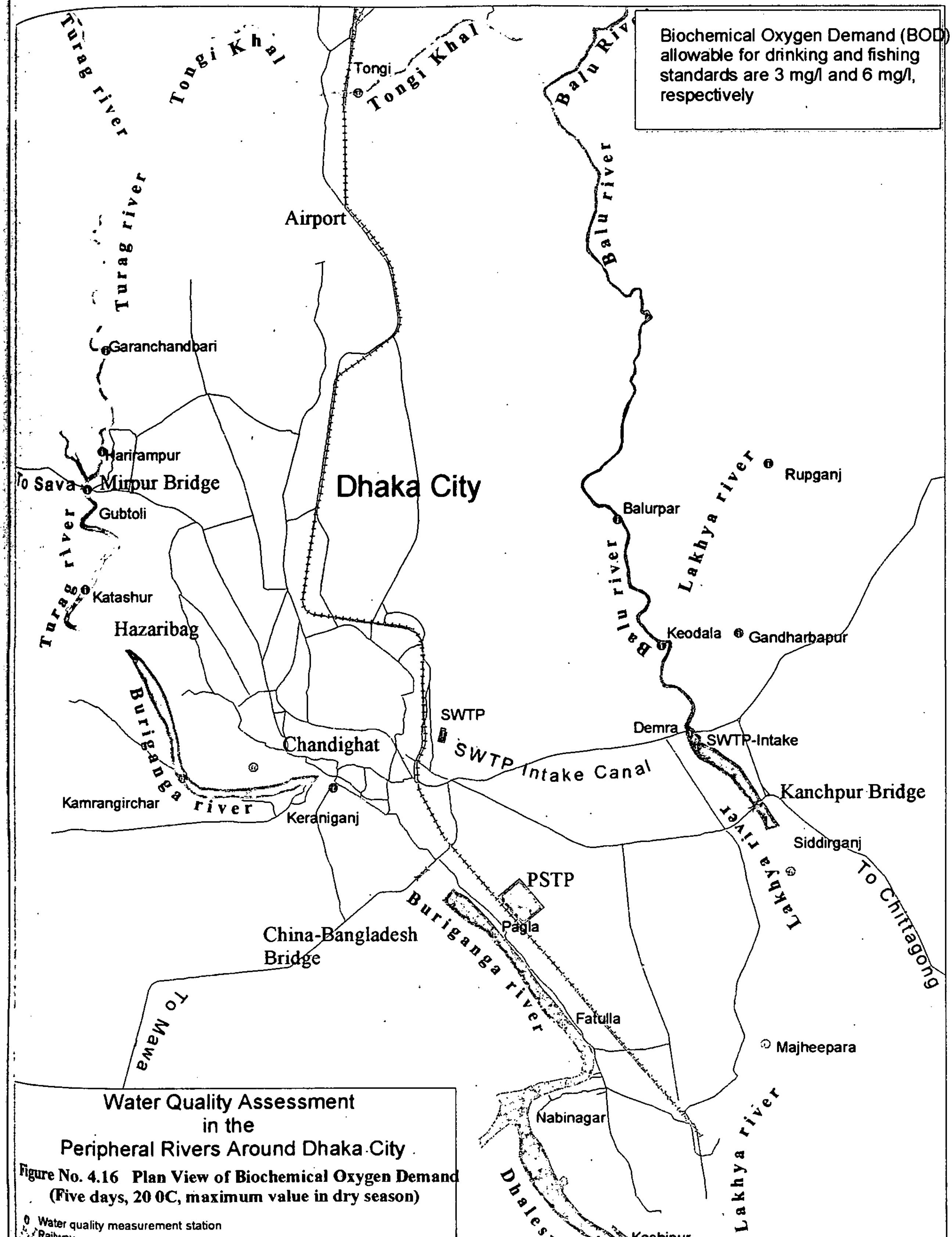


Figure No. 4.16 Plan View of Biochemical Oxygen Demand (Five days, 20 0C, maximum value in dry season)

Historical Trend of BOD Concentration

Historical observations of BOD since 1980 at Mirpur and Hazaribag on the Turag river and at Chandighat and Pagla on the Buriganga river have been plotted intermittently in Figure 4.17, 4.18, 4.19 and 4.20, respectively. A gradual increase of BOD is seen along the entire river system. A sudden high BOD is observed in 1998 possibly due to extreme cold weather (temperature around 19 ^{0}C). Very low BOD at Pagla on the Buriganga river during April'2004 is observed due to dilution resulting from early pre-monsoon rainfall.

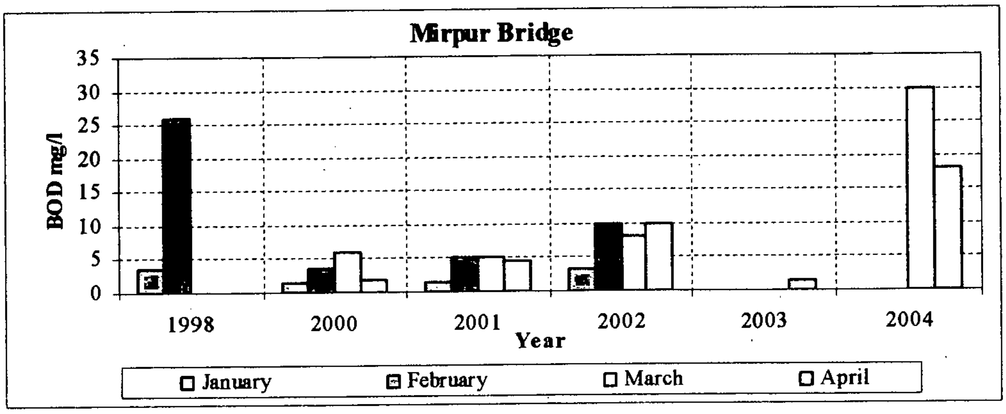


Figure 4.17 Biochemical oxygen demand (BOD_5 at 20 ^{0}C) at Mirpur Bridge on the Turag River (Data source: Kamal, 1996; WSP International, 1998; IWM, 2005)

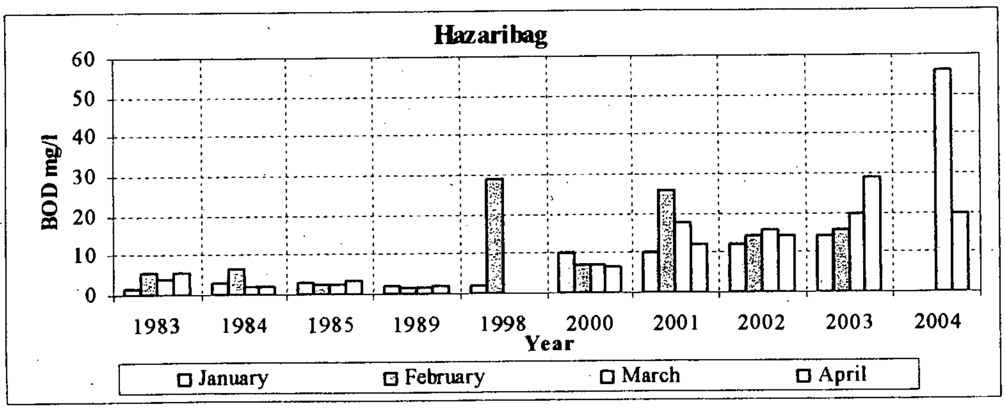


Figure 4.18 Biochemical oxygen demand (BOD_5 at 20 ^{0}C) at Hazaribag on the Buriganga river (Data source: Kamal, 1996; WSP International, 1998; IWM, 2005)

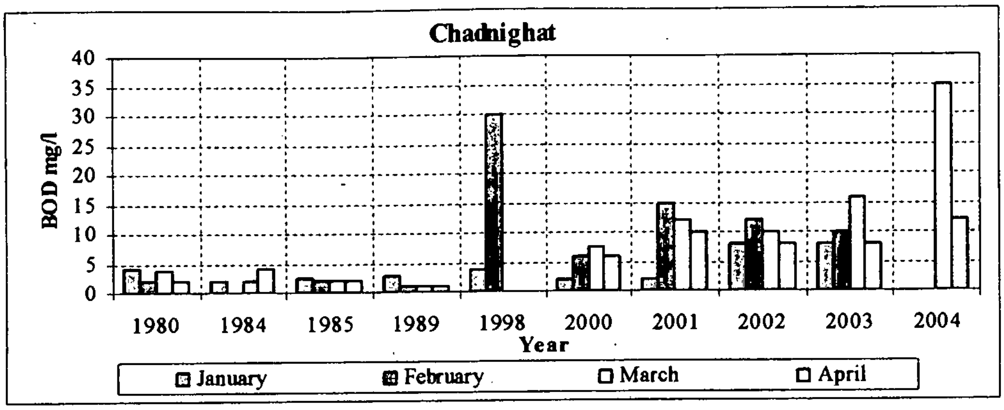


Figure 4.19 Biochemical oxygen demand (BOD_5 at 20 ^0C) at Chadnighat on the Buriganga river (Data source: Kamal, 1996; WSP International, 1998; IWM, 2005)

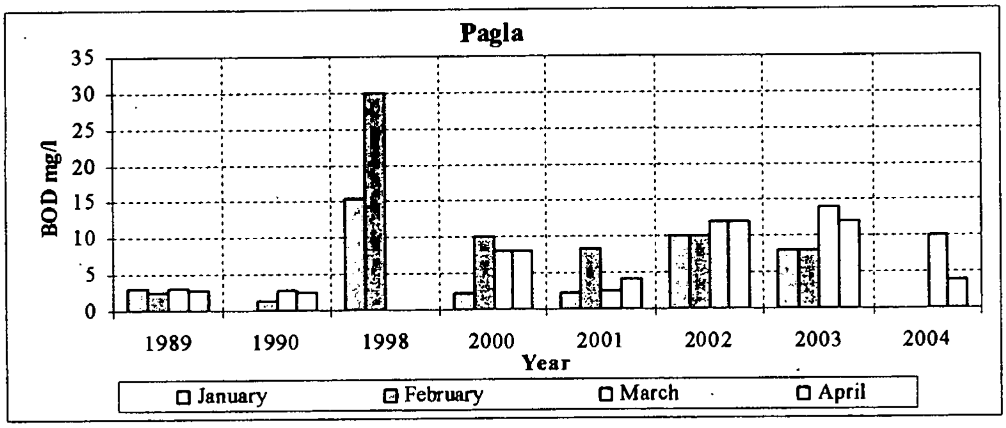


Figure 4.20 Biochemical oxygen demand (BOD_5 at 20 ^0C) at Pagla on the Buriganga river (Data source: Kamal, 1996; WSP International, 1998; IWM, 2005)

4.3.3 Chemical Oxygen Demand (COD)

Present Scenario

Measured chemical oxygen demand (COD, dichromate value) throughout the entire river system is available of Apr'03, Dec'03, Mar'04 and Apr'04. Plots of four measurements have been shown in Figure C.8 to C.11 in Appendix-C. Chemical oxygen demand (COD) in the Turag river and upper reaches of the Buriganga river remains high varying from 50 mg/l to 60 mg/l except Hazaribag having COD of around of 90 mg/l. COD is drastically reduced to below 20 mg/l from Pagla in the Buriganga river and is continued in the entire Dhaleswari river. Along the Lakhya river, COD varies from 20 to 45 mg/l. High COD is observed in the Tongi khal (105 mg/l). A variation of COD from 40 mg/l to 60 mg/l is observed along the Balu river. Profile of maximum COD, occurred at different stations on the river system during four recent campaigns has been shown in Figure 4.21.

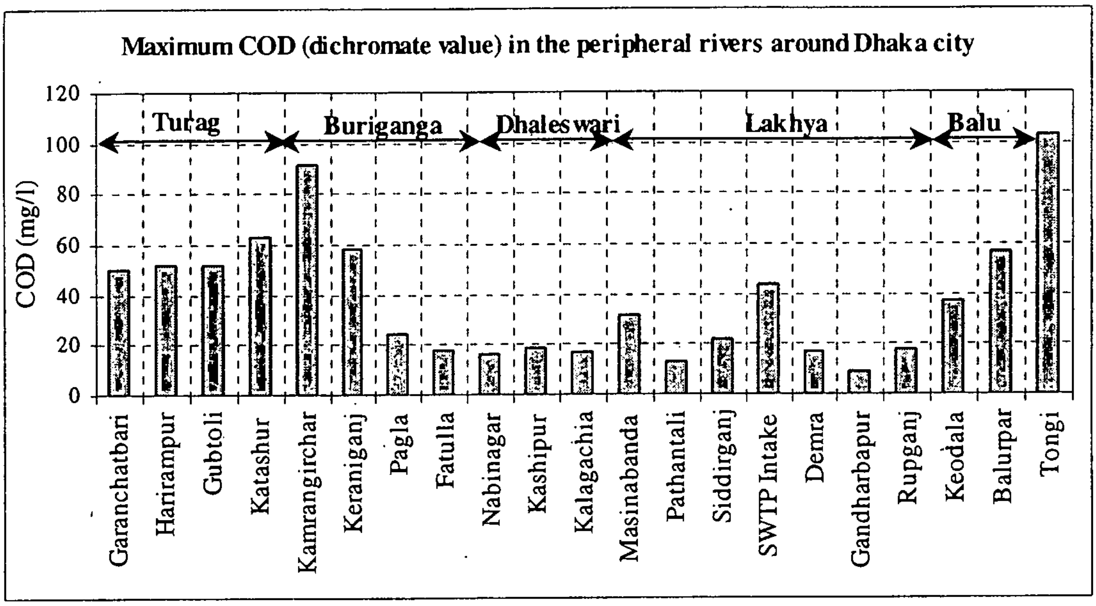


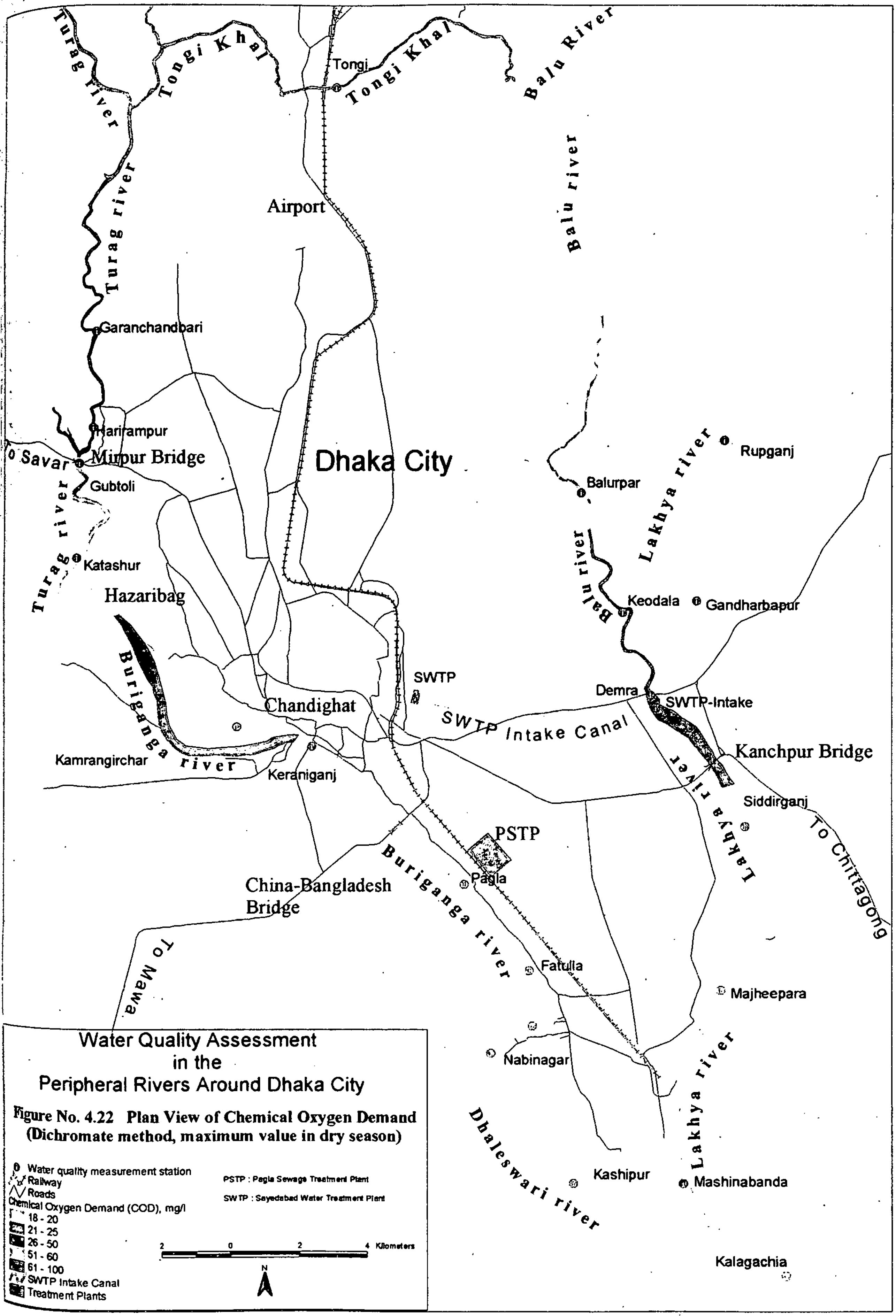
Figure 4.21 Profile of maximum chemical oxygen demand (COD, dichromate value) in the peripheral river system around the Dhaka city (Observations: Apr'03, Dec'03, Mar'04 and Apr'04) (Data Source: IWM, 2005)

The plan view of maximum chemical oxygen demand (COD) measured during the last two dry seasons (Apr'03, Dec'03, Mar'04 and Apr'04) in the river system has been depicted in Figure 4.22 and summarized below:

River / Khal reach	COD, Dichromate Value (mg/l)
Turag river	50 to 60
Buriganga river (Hazaribag to Keraniganj)	60 to 90
Buriganga river (Keraniganj to Fatulla)	around 20
Dhaleswari river	below 20
Lakhya river (Mosinabanda to Demra)	30 to 40
Lakhya river (Demra to Rupganj)	below 20
Balu river	40 to 60
Tongi Khal	about 100

Historical Trend of Chemical Oxygen Demand

Long – term COD data along the Turag-Buriganga river system is not available sufficiently and that only at Hazaribag and Chandnighat have been plotted as shown in Figure 4.23 and 4.24, respectively. A distinct trend is not observed due to insufficient records. However, a remarkable increase in COD with years at Hazaribag can be envisaged. The trend would be more distinct if there were available more records.



Water Quality Assessment
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Figure No. 4.22 Plan View of Chemical Oxygen Demand (Dichromate method, maximum value in dry season)

High COD nearly 200 mg/l was observed during 1988 at Hazaribag and the common value ranges from 40 mg/l to 120 mg/l (Figure 4.23). A gradual increase of COD is observed at Chandighat on the Buriganga river. The maximum COD occurred about 68 mg/l during 2001 (Figure 4.24). COD at Chandnighat varies from 50 mg/l to 68 mg/l in the last 15 years.

From historical records it is noteworthy that COD content remains high normally in February and March in each year. Historical trend would be more distinct if records of February during 2004 were available.

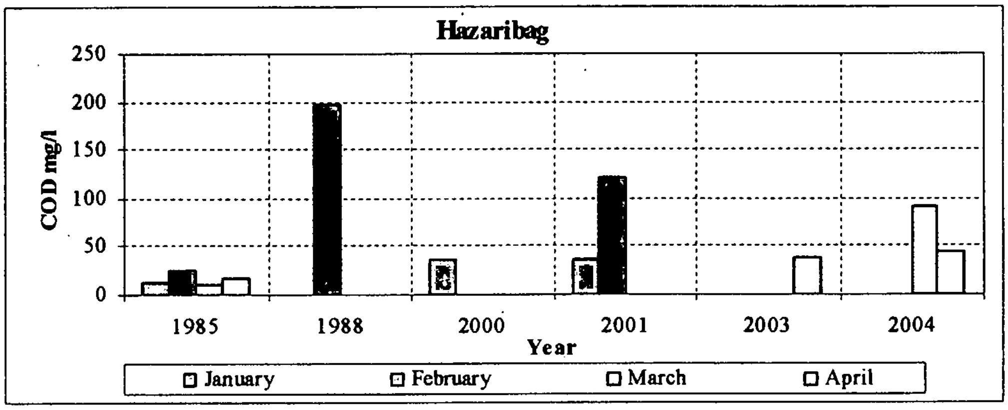

Figure 4.23 Chemical oxygen demand (COD, dichromate value) at Hazaribag on the Buriganga river (Data source: Kamal, 1996; WSP International, 1998; IWM, 2005)

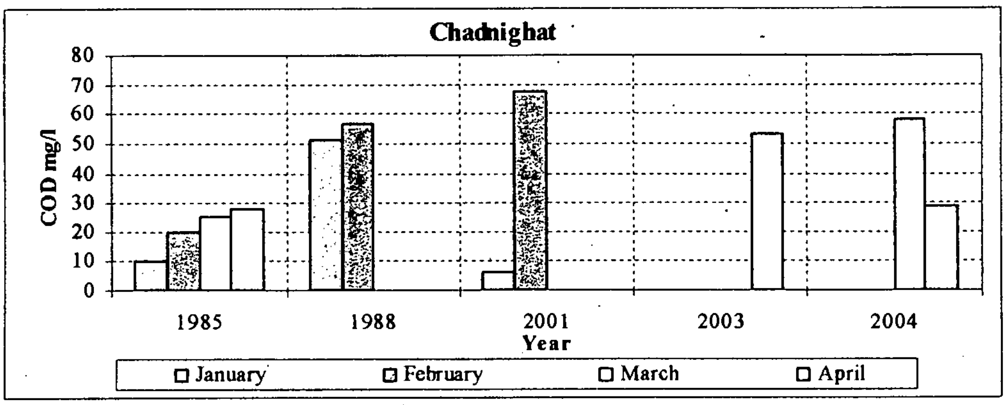

Figure 4.24 Chemical oxygen demand (COD; dichromate value) at Chandighat on the Buriganga river (Data source: Kamal, 1996; WSP International, 1998; IWM, 2005)

Ratio of BOD and COD in the Stream Water

The ratio of BOD with COD varies in different river system. The ratio ranges from 0.40 to 0.6 in the Turag river, Balu river and Lakhya river (Figure 4.25). The ratio varies from 0.4 to 0.8 in the Dhaleswari river.

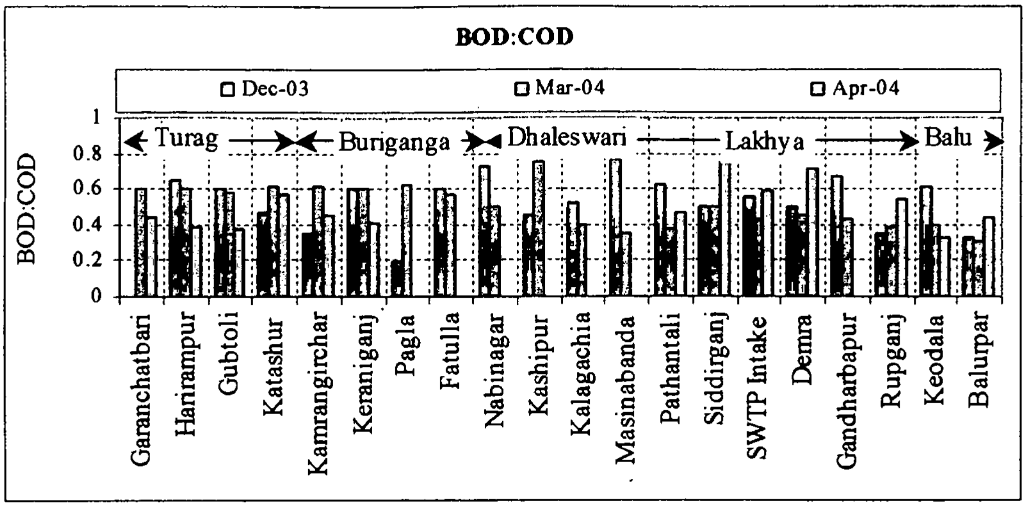

Figure 4.25 Ratios of BOD with COD along the peripheral rivers

4.3.4 Nitrogen

Nitrogen content at three states i.e. NH_3-N, NH_4^+-N and NO_3-N have been evaluated in the river system. Profiles of measured ammonia-nitrogen have been shown in Figure C.12 in Appendix-C. High ammonia-nitrogen concentration (around 10 mg/l) is observed at Kamrangirchar and Keraniganj on the Buriganga river. The same figure is also found in the Balu river. In the Lakhya river, ammonia-nitrogen concentration ranges from 3 to 8 mg/l in the reach between Demra and Siddhirganj. Maximum NH_3 –N concentration in the river system is more than the allowable limit USEPA guideline (0.02 mg/l) to avoid toxic effect for fishes. Ammonia content is below the 0.02 mg/l in the Dhaleswari river. Profile of maximum ammonia-nitrogen content has been shown in Figure 4.26 and plan view of maximum ammonia-nitrogen content has been shown in Figure 4.27.

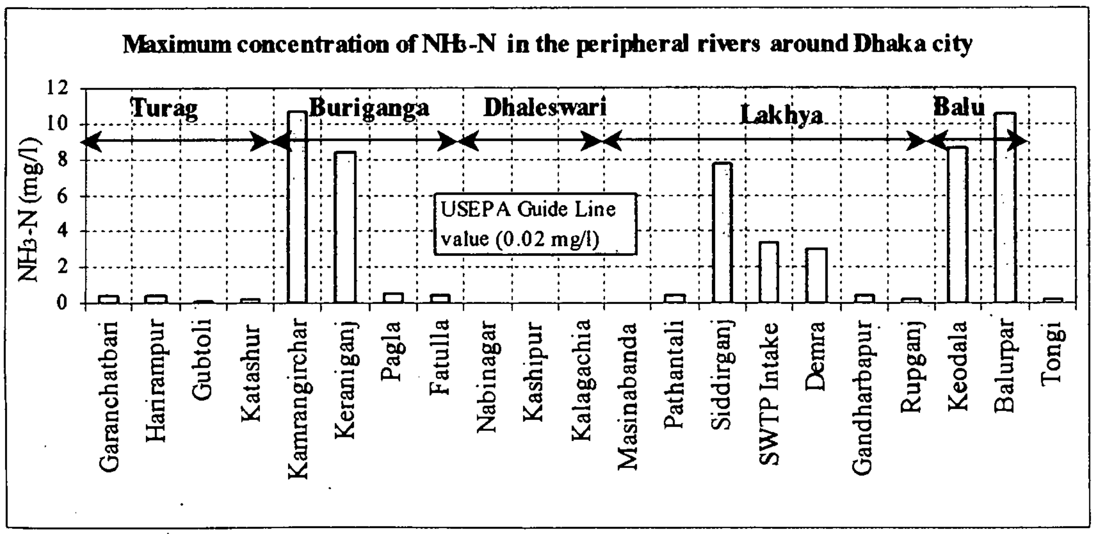

Figure 4.26 Profile of maximum ammonia nitrogen (NH_3-N) concentration in the peripheral river system (Observations: Apr'03, Dec'03, Mar'04 and Apr'04) (Data Source: IWM, 2005)

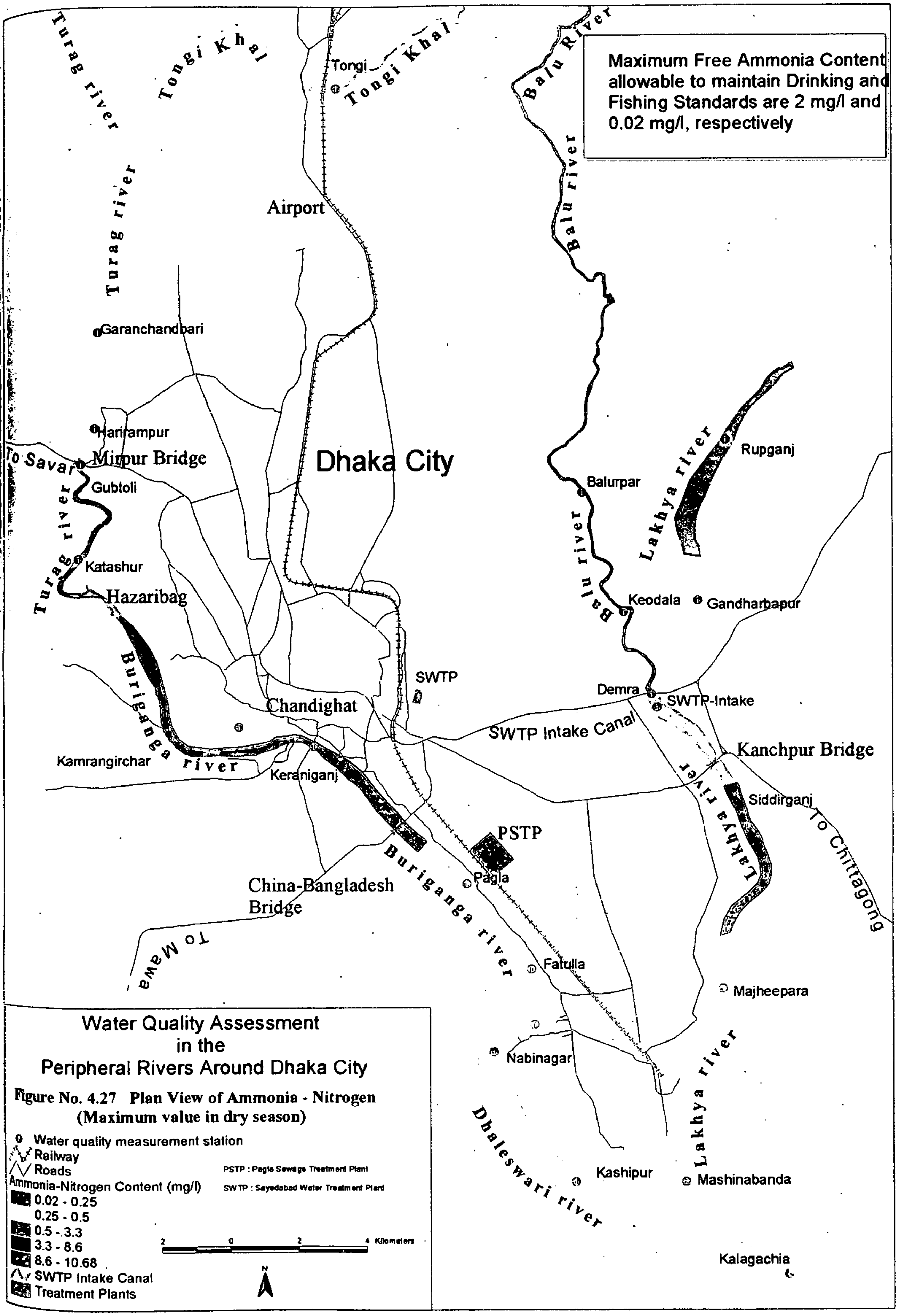

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Figure No. 4.27 Plan View of Ammonia - Nitrogen (Maximum value in dry season)

Measured ammonium (NH_4^+-N) concentrations in the river system have been plotted in Figure C.14 in Appendix-C. Ammonium (NH_4^+-N) concentration reaches nearly 20 mg/l in the Turag river and Buriganga river (Figure 4.28). The Dhaleswari river and Lakhya river experience ammonium-nitrogen of 2 mg/l or less except Sarulia where the concentration occurs a little high. Ammonium-nitrogen concentration ranges from 4 to 12 mg/l in the Balu river.

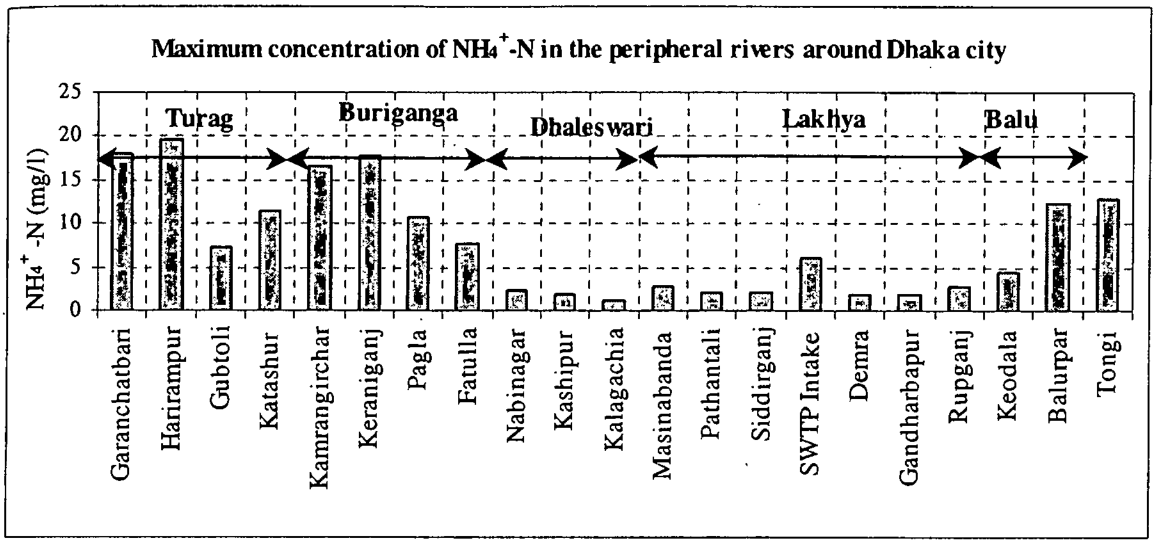

Figure 4.28 Profile of maximum ammonium nitrogen (NH_4^+-N) concentration in the peripheral river system (Observations: Apr'03, Dec'03, Mar'04 and Apr'04) (Data Source: IWM, 2005)

Measured nitrate concentrations have been plotted in Figure C.14 in Appendix-C. Nitrate content is below 10 mg/l (Bangladesh guideline value) in the entire river system except Hazaribag where the same reaches to about 18 mg/l (Figure 4.29).

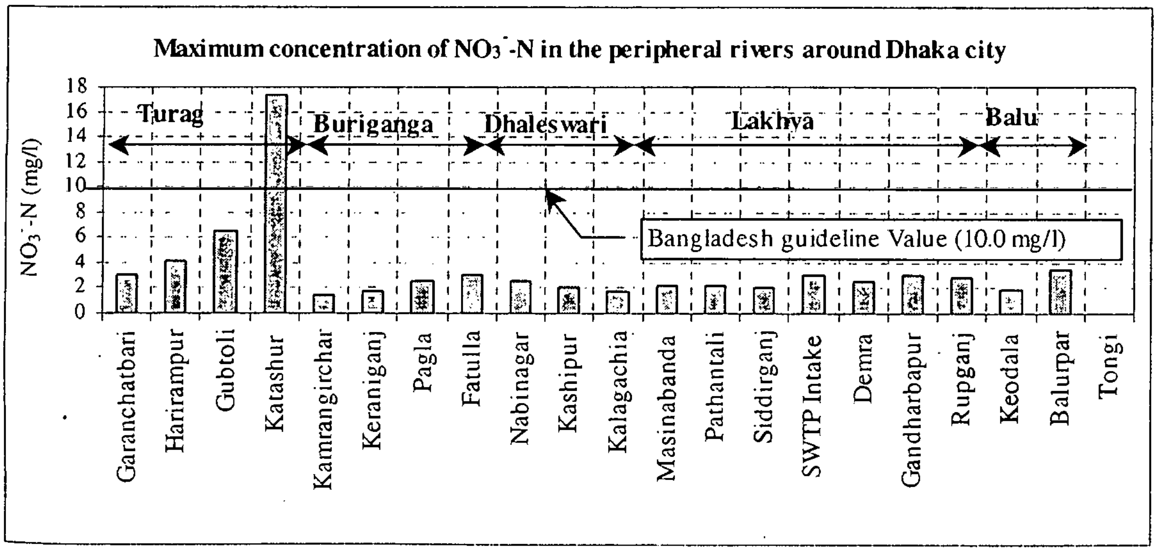

Figure 4.29 Profile of maximum nitrate nitrogen (NO_3^--N) concentration in the peripheral river system (Observations: Apr'03, Dec'03, Mar'04 and Apr'04) (Data Source IWM, 2005)

Total nitrogen content (NH_3-N + NH_4^+-N + NO_3^--N) remains more than 5 mg/l in the entire river reaches except the Dhaleswari river, (Figure 4.30) where the same is less than 5 mg/l.

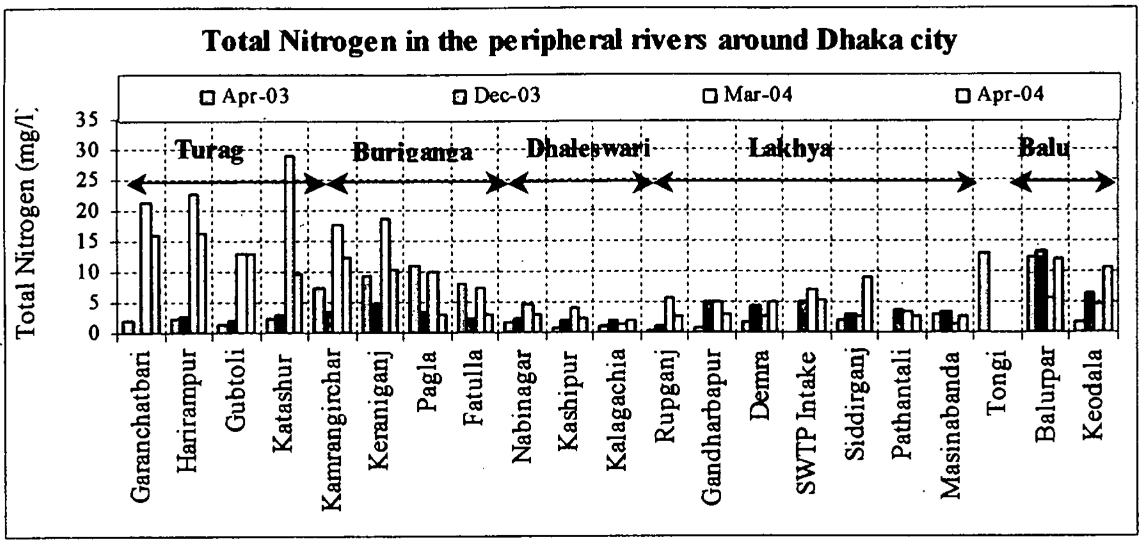

Figure 4.30 Profile of total nitrogen (NH_3-N + NH_4^+-N + NO_3^--N) content in the peripheral river system (Observations: Apr'03, Dec'03, Mar'04 and Apr'04) (Data Source IWM, 2005)

4.3.5 Phosphate (PO_4^{3-})

Phosphate has been measured in river system during April'2004 data campaign. Concentration less than 0.50 mg/l is observed in the Buriganga and Dhaleswari river. The concentration is quite high ranges from 1.5 to 4.5 mg/l in the Turag, Balu and Lakhya river. However, all the figures are less than drinking standard followed by Bangladesh guideline value i.e. 6.00 mg/l (Figure 4.31).

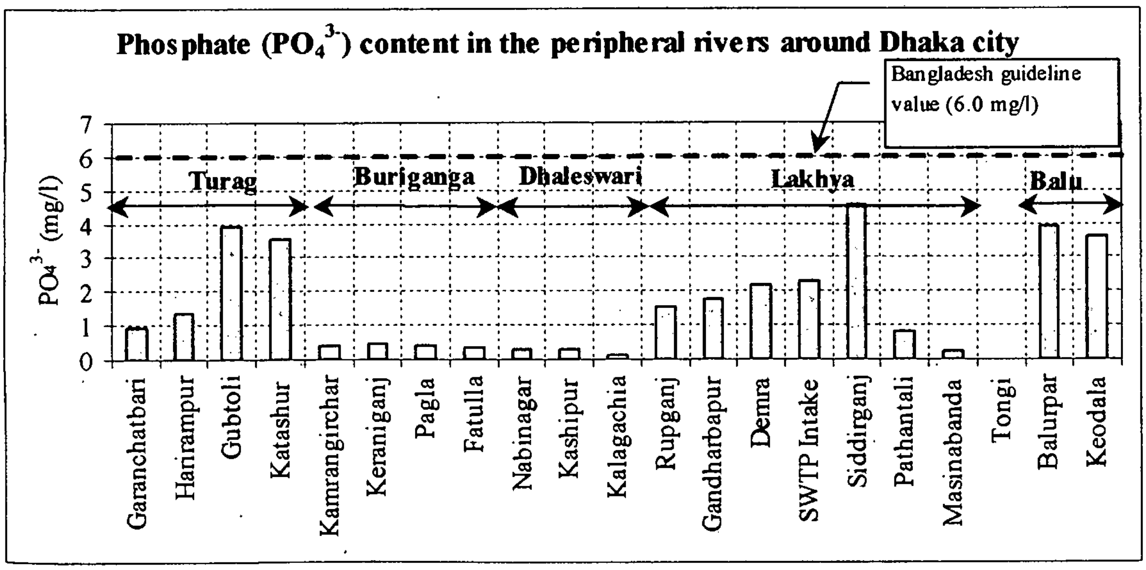

Figure 4.31 Profile of phosphate (PO_4^{3-}) concentration in the peripheral rivers system (Apr'04) (Data Source IWM, 2005)

4.3.6 Heavy Metal (Chromium, Lead, Mercury, Zinc)

Chromium (Cr)

Chromium concentration in the river reaches is quite low than the allowable limit of Bangladesh guideline value (0.050 mg/l) except Hazaribag, where the concentration rises above 0.25 mg/l due to discharge of effluent from tanning industries. The maximum concentrations have been shown in Figure 4.32. The observations in different campaigns have been plotted in Figure C.15 in Appendix-C.

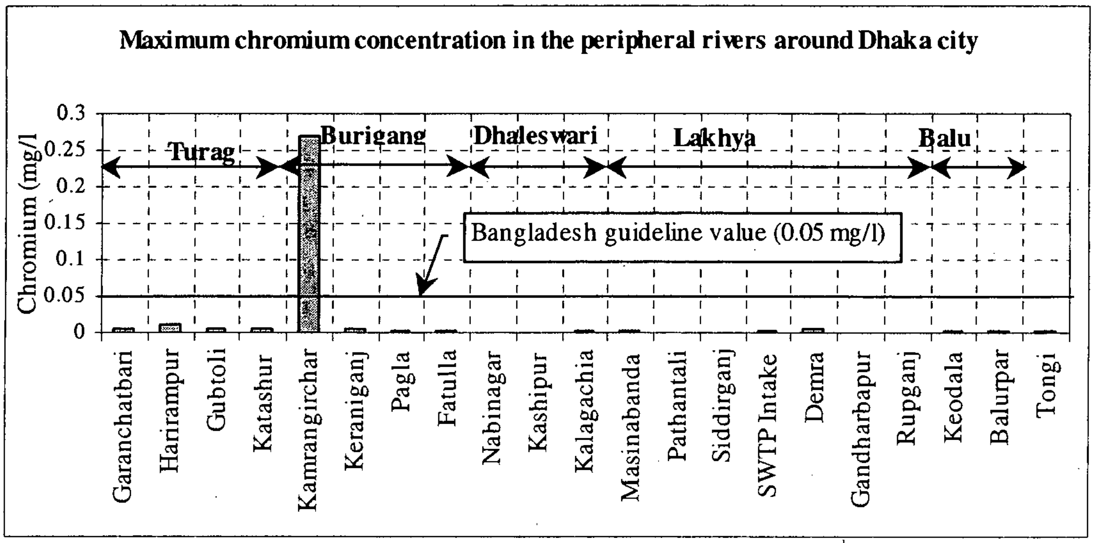

Figure 4.32 Profile of maximum chromium content in the peripheral rivers (Observations: Apr'03, Dec'03, Mar'04 and Apr'04) (Data Source IWM, 2005)

Mercury (Hg)

Mercury concentrations had been measured during April'2003. The concentrations were less than the minimum detection limits i.e. 0.001 µg/l along the entire river reaches. The same result has been found in the measurement at Sarulia on the Lakhya river on February and March in 2004.

It is found that Chromium and Lead are accumulated in the dry period since it is non-biodegradable and no net flow occurs except tidal thrust. Measured data represent that lead and chromium concentrations increase in March than that of December or January

Lead (Pb)

Lead concentrations in the peripheral rivers have been measured in four campaigns (Apr'03, Dec'03, Mar'04 and Apr'04) and have been shown in Figure C.16 and C.17 in Appendix-C. Lead content observed in April 2003 is quite high compared to the other three campaigns. Possibly it may be associated with errors in testing. Maximum lead concentrations of the three campaigns have been shown in Figure 4.33, which reveal that lead content remains almost below the allowable limit of WHO guideline value (0.01 mg/l) in the river system.

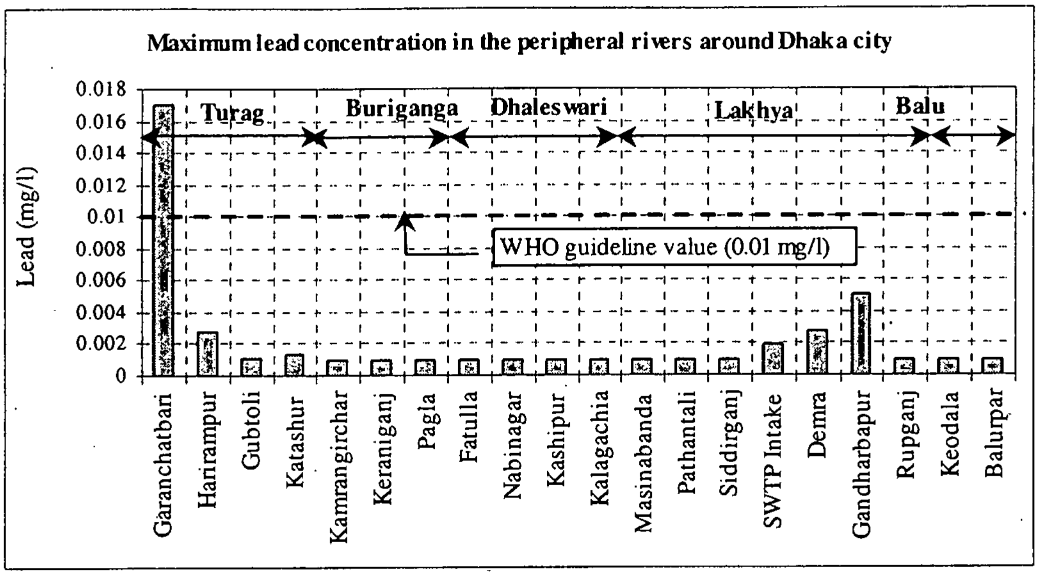

Figure 4.33 Profile of maximum lead content in the peripheral river system (Observations: Apr'03, Dec'03, Mar'04 and Apr'04) (Data Source: IWM, 2005)

Zinc (Zn)

Recent observation of zinc is not available. Zinc content in the peripheral river measured during Feb'98 has been plotted in Figure 4.34, which represents that concentration of zinc is below the allowable limit of USEPA guideline value (5.0 mg/l) for drinking standard throughout the entire river system. But zinc content in the river system is more than the allowable limit for fishes (0.03 mg/l) specified in Canadian standard.

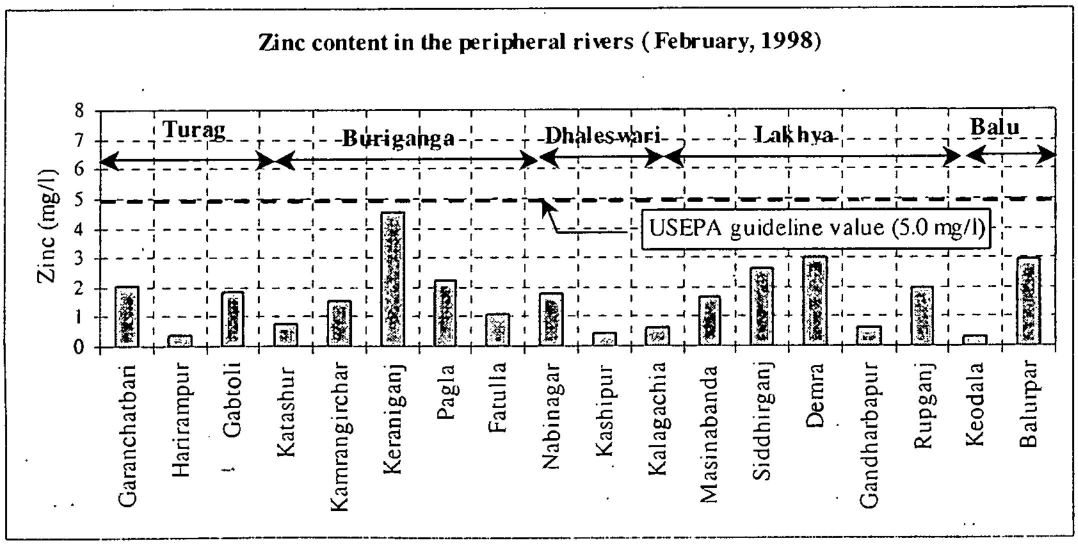

Figure 4.34 Profile of zinc content in the peripheral river system (Feb'1998) (Data Source: WSP International, 1998)

4.3.7 Alkalinity

Alkalinity data has been collected from Department of Environment since 2000 to 2003. Data has been analyzed only for dry period. Maximum total alkalinity in the entire river system is around 200 mg/l as $CaCO_3$ or less. The common variation ranges from 75 mg/l to 175 mg/l ($CaCO_3$) (Figure 4.35). pH of the river system is below 8.0 (Figure 4.36), therefore, the contained alkalinity is mostly bicarbonate type.

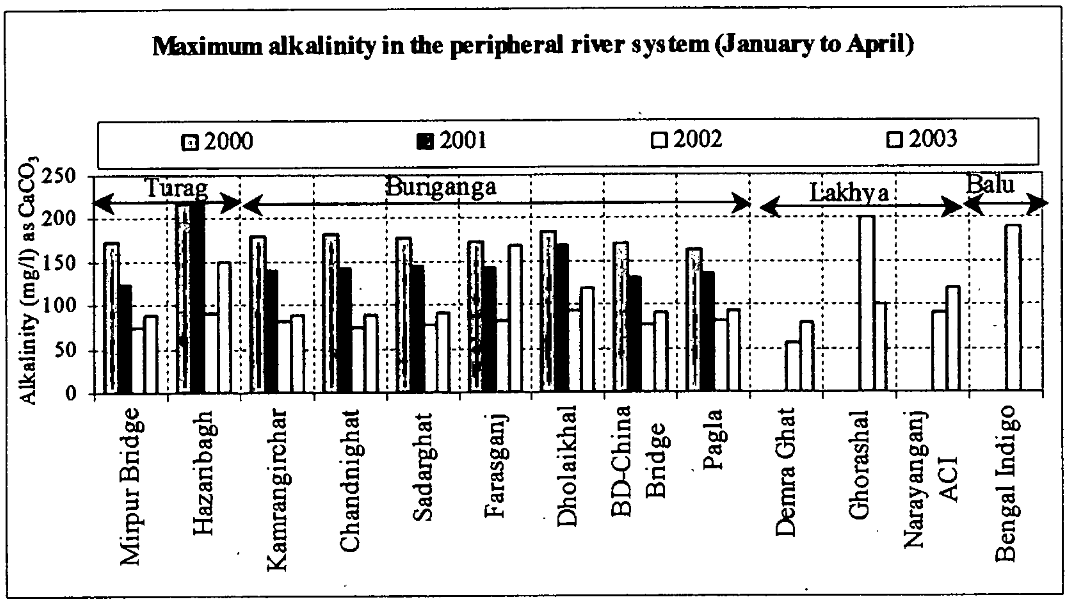

Figure 4.35 Profile of total alkalinity in the peripheral rivers system (Data Source: IWM, 2004)

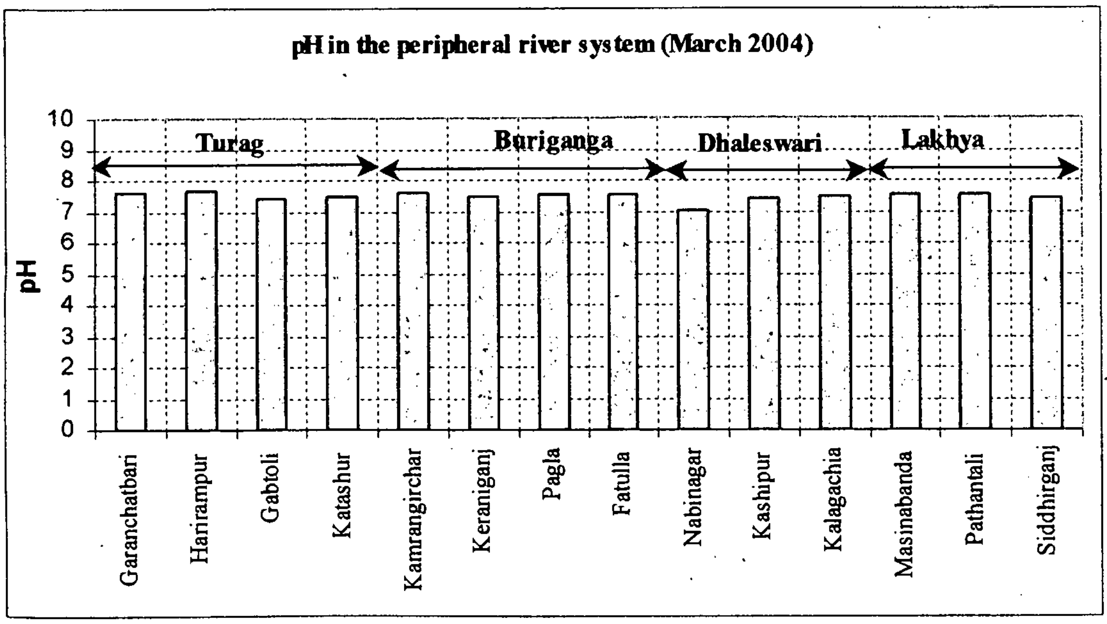

Figure 4.36 Profile of pH in the peripheral rivers system (Data Source: IWM, 2005)

4.3.8 Chloride

Chloride content usually remains high in the dry season and vice versa in the river system. It starts to rise from December and gets maximum in April or May and then falls being minimum in September. Highest concentration normally occurs at Hazaribag on the Buriganga river resulting from disposal of tannery effluent. Chloride concentration at Hazaribag during dry period ranges from 40 to 60 mg/l where a few of the high values reach to about 200 mg/l. At Chandnighat, chloride content ranges from 30 to 50 mg/l and value over 80 mg/l is rare. Chloride content at Pagla on the Buriganga river does not exceed 50 mg/l and less than 30 mg/l is common. The plots of Chloride concentration at Hazaribag, Chandnighat and Pagla have been shown in Figure 4.37, 4.38 and 4.39, respectively. Observation of chloride in the Dhaleswari river is not available. However, it can be anticipated that chloride content in the Dhaleswari river will not exceed that of the Buriganga river as well as the Lakhya river. Maximum permissible limit of chloride content is 250 mg/l according to the guideline of both WHO and USEPA specified for drinking water. Bangladesh guideline value is more flexible which has specified chloride content for drinking water varying from 160 to 600 mg/l. Therefore, chloride content is below the allowable limit specified in different drinking, fishing, recreational and agricultural water quality standards in the entire river system.

4.3.8 Suspended Solids

Measured suspended solid (SS) data is available from 1980 to 1994 of the Turag-Buriganga river system at Hazaribag, Chandnighat and Pagla (Kamal, 1996). The analysis has been done throughout the year at those stations and the plots have been shown in Figure 4.40, 4.41 and 4.42, respectively. At Chandnighat, the concentration of total suspended solid mostly ranges from 40 to 60 mg/l. A few of the cases, the value reaches to about 115 mg/l. The same scenario is observed at Hazaribag and Pagla monitoring stations. The total solids content at Sarulia on the Lakhya river on February 2004 was 388 mg/l (IWM, 2004). Out of which suspended solids and dissolved solids were 24 mg/l and 365 mg/l, respectively during March'2004 (IWM, 2004). It is observed that suspended solid content varies with season and remains high during January to August period. It is observed less suspended solid content in September to December months. Suspended solids are totally unexpected in drinking water.

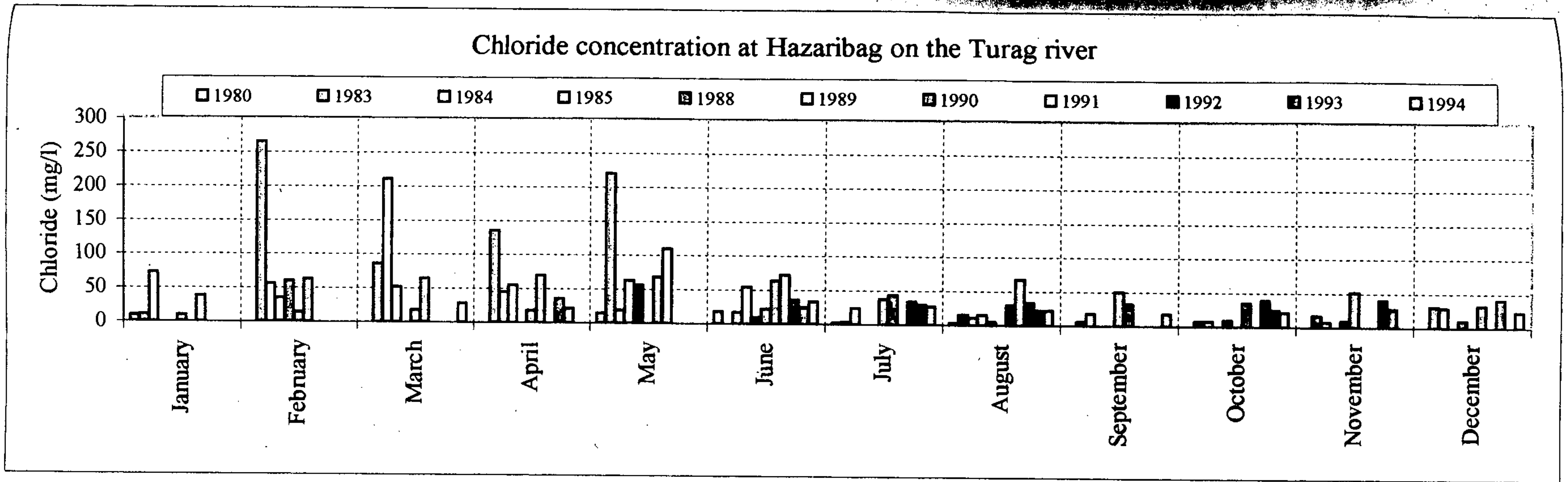

Figure 4.37 Chloride concentration at Hazaribag on the Turag river (Data source : Kamal, 1996)

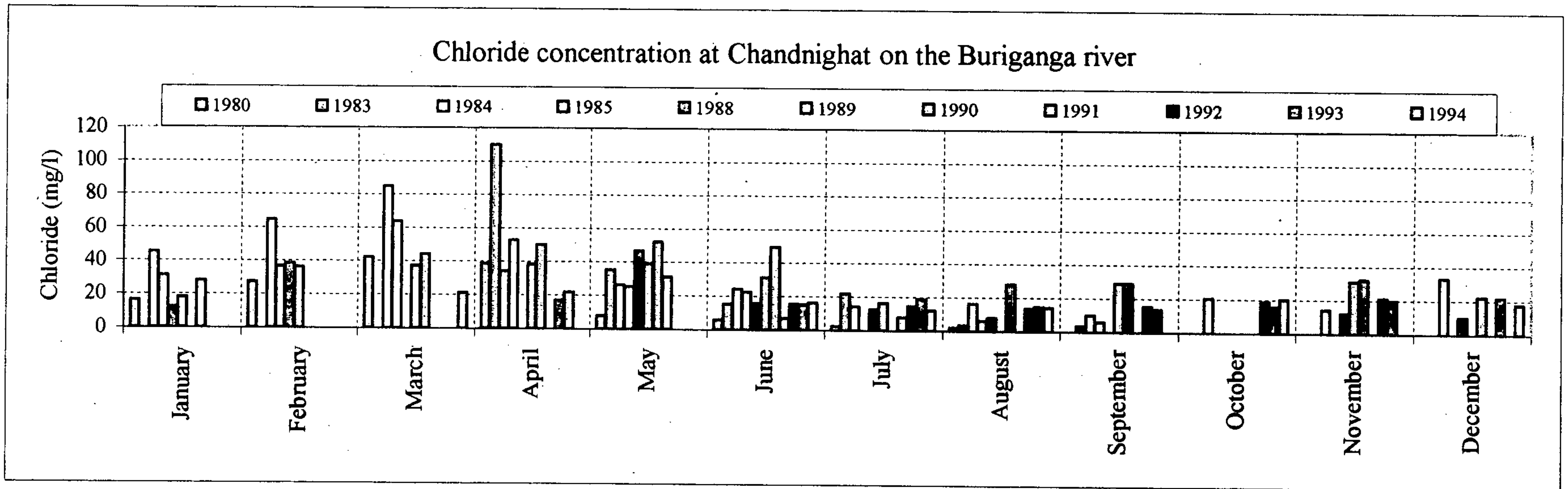

Figure 4.38 Chloride concentration at Chandnighat on the Buriganga river (Data source : Kamal, 1996)

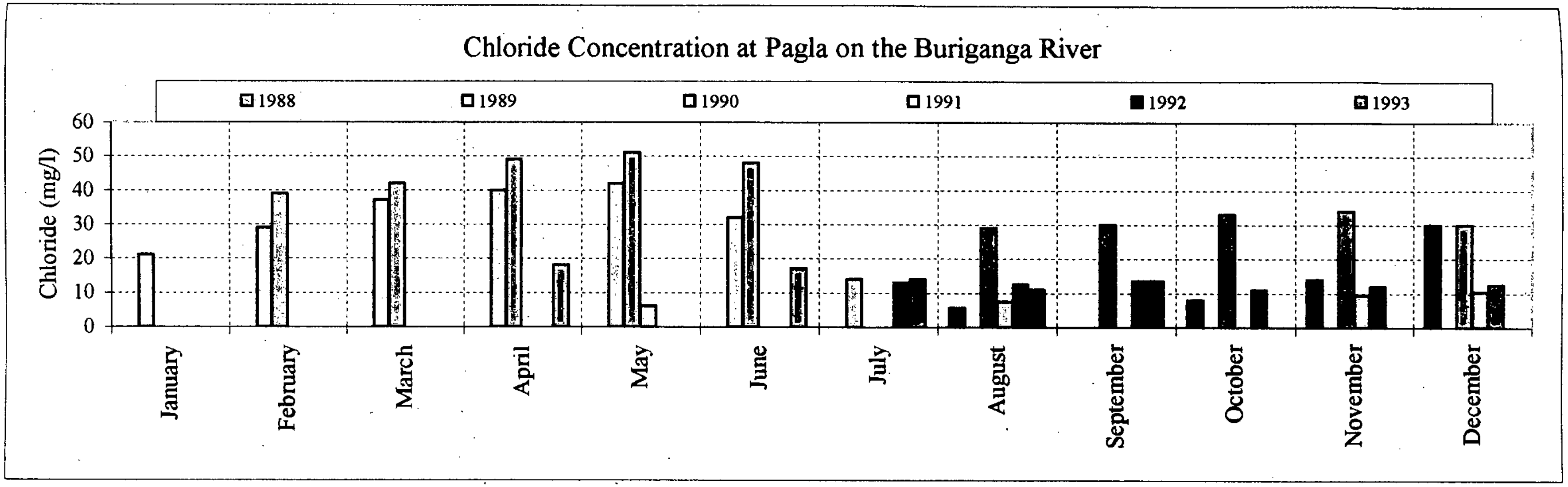

Figure 4.39 Chloride concentration at Pagla on the Buriganga river (Data source : Kamal, 1996)

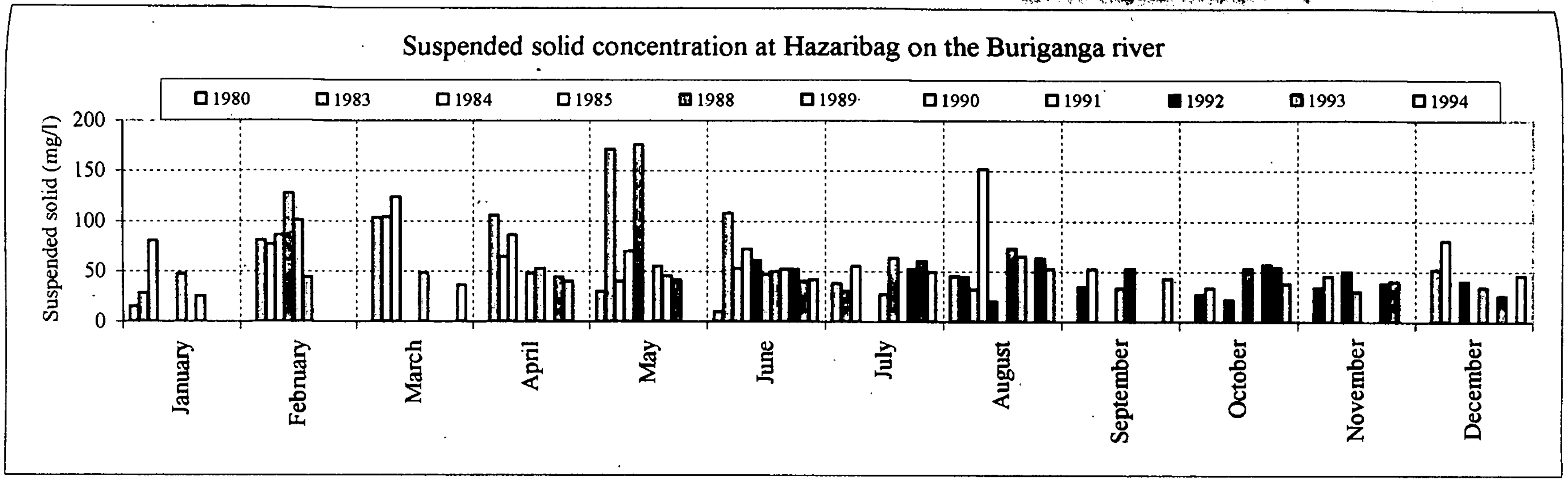

Figure 4.40 Suspended solid (SS) concentration at Hazaribag on the Turag river (Data source : Kamal, 1996)

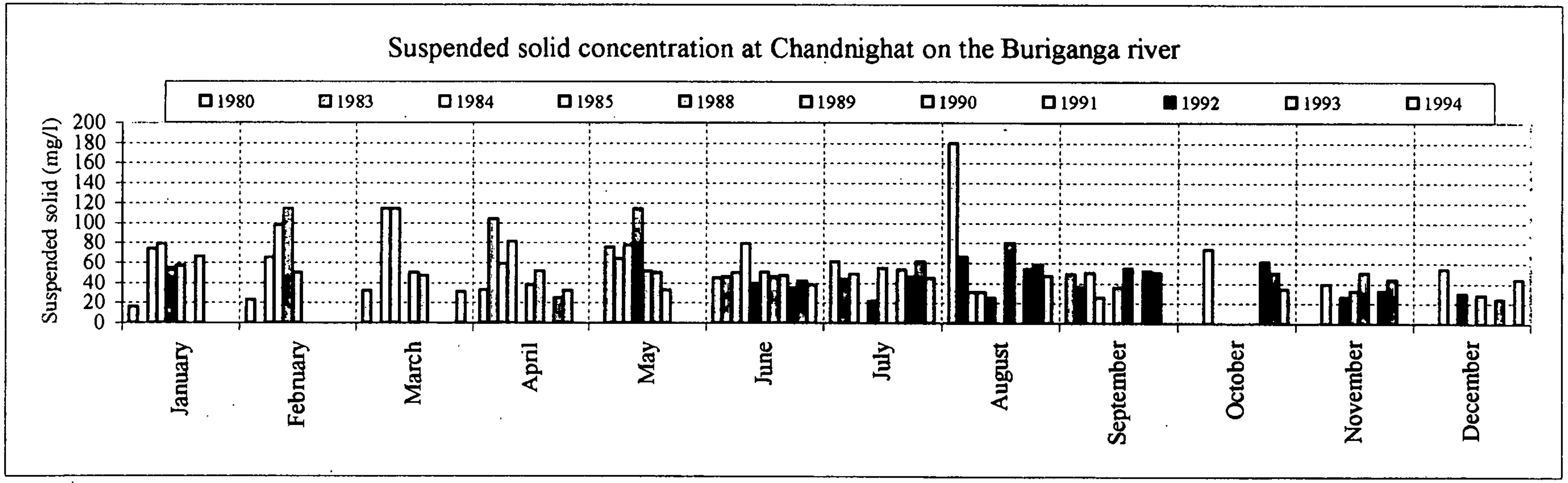

Figure 4.41 Suspended solid (SS) concentration at Chandnighat on the Buriganga river (Data source : Kamal, 1996)

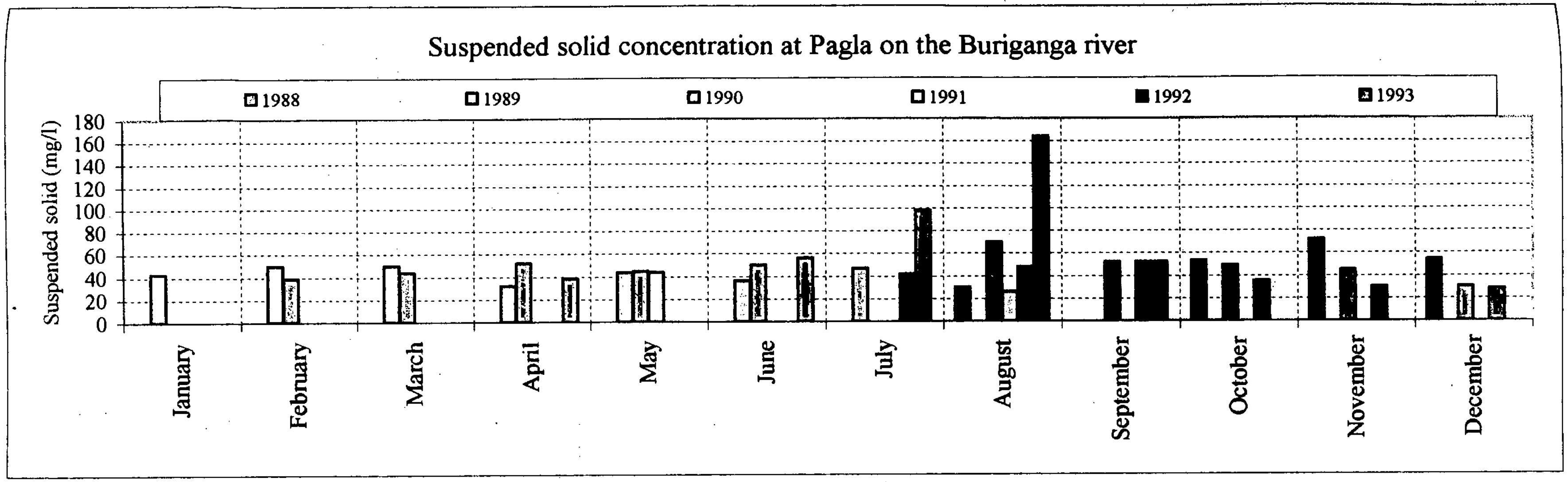

Figure 4.42 Suspended solid (SS) concentration at Pagla on the Buriganga river (Data source : Kamal, 1996)

4.3.10 Turbidity

Turbidity is high in the Turag river and Buriganga river ranges from 5 to 40 NTU. Relatively less turbidity is observed in the Lakhya river and Balu river varying from 5 to 10 NTU. Measured turbidity has been plotted in Figure 4.43. Turbidity observation in the Dhaleswari river is not available. Like suspended solid, turbidity also varies with season and usually remains high in flood period (Figure 4.44 and Figure 4.45). Turbidity data procured by IWM from DOE show significant variation between that of 2000 and 2002. Turbidity observed during 2002 is much less than that of 2000 and possibly data of 2002 is erroneous.

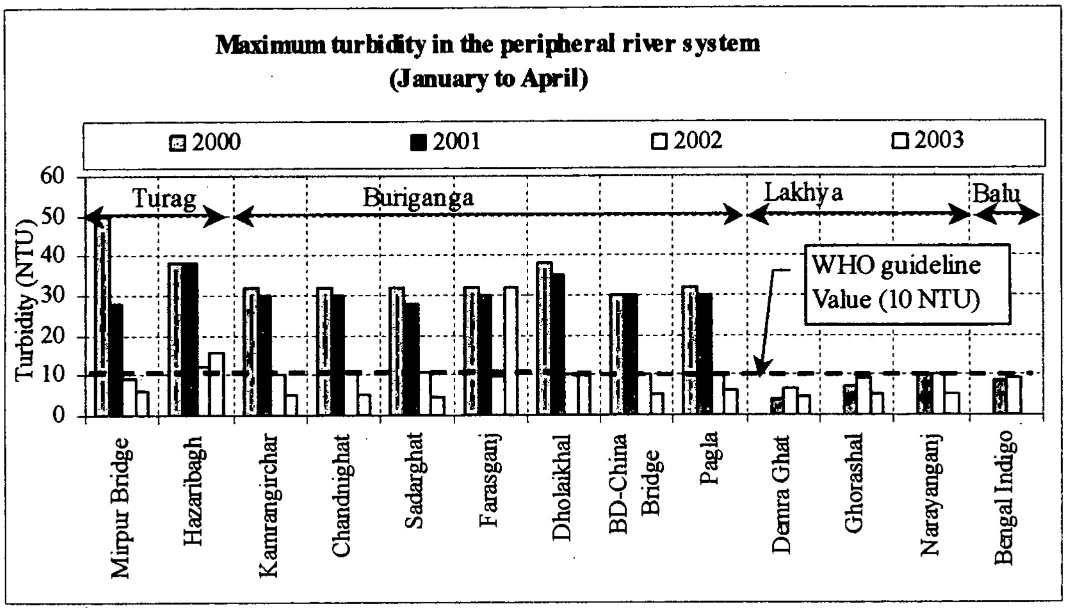

Figure 4.43 Profile of maximum turbidity in the peripheral river system during dry period (Data Source: IWM, 2004)

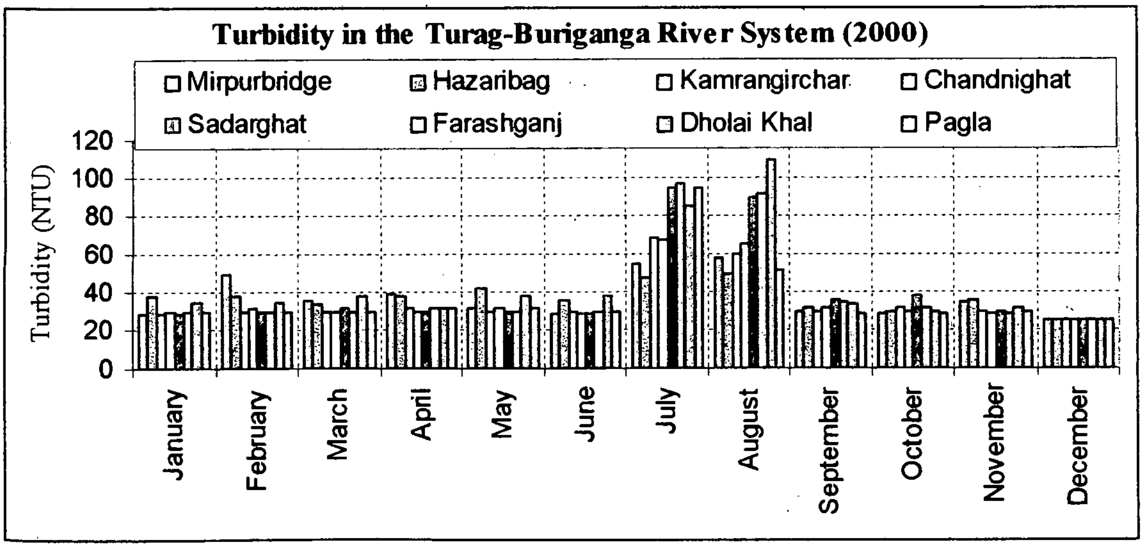

Figure 4.44 Seasonal variation of Turbidity in the Turag-Buriganga River system, 2000 (Data Source: IWM, 2004)

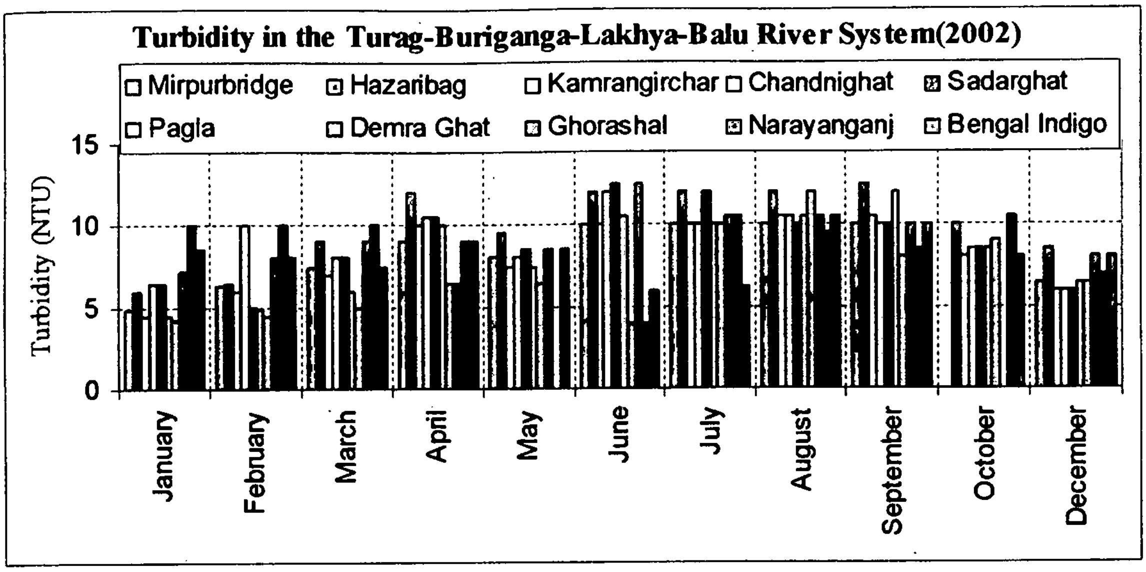

Figure 4.45 Seasonal variation of Turbidity in the Turag-Buriganga-Lakhya-Balu River system, 2002 (Data Source: IWM, 2004)

4.3.11 Coliform

Long term observation of coliform is not available. It was measured at Sarulia during February'2004. The concentration of total coliform and Fecal were too numerical to count (TNTC) and 400,000 /100 ml, respectively. Recent measurements of IWM show also excessive content of coliform. High concentration of Fecal Coliform can be expected in the entire river reaches since they are receiving huge domestic sewage from the city and its outsides. Fecal coliform observed during Feb'98 has been plotted in Figure 4.46, which represents that higher Fecal coliform exist in the Turag river, Balu river and upper reach of the Buriganga river. Fecal coliform content remains low in the Lakhya river and Dhaleswari river. However, coliforms are completely unexpected in drinking water.

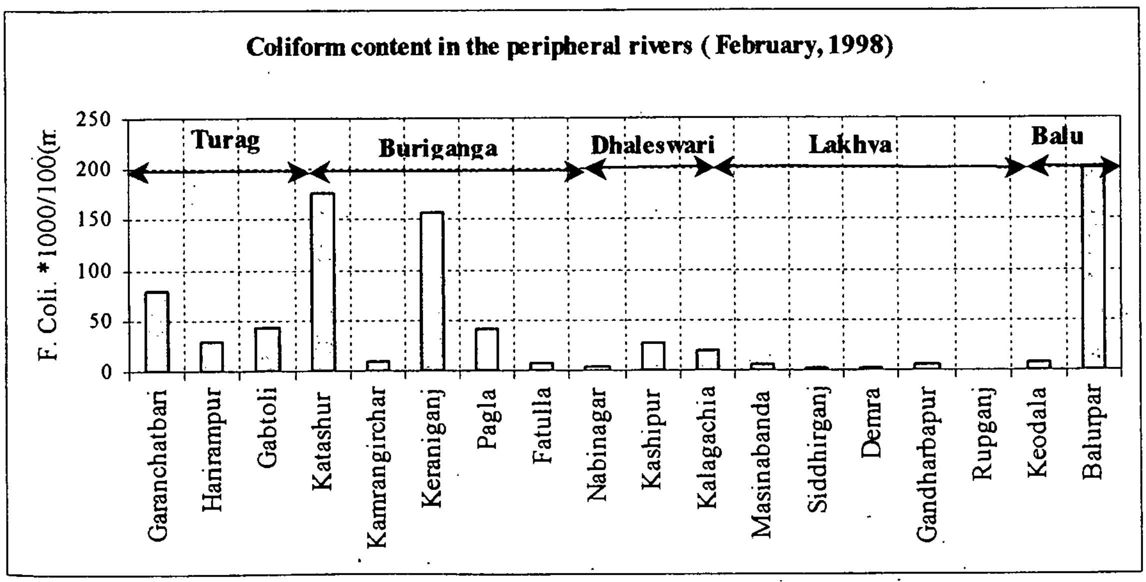

Figure 4.46 Profile of fecal coliform content in the peripheral river system (February, 1998) (WSP International, 1998)

Water quality in the entire river system has been summarized in the following table (Table 4.1)

Table 4.1 Water quality in brief in the peripheral river system of the Dhaka city

Parameter	Standard Value for different Uses				Observed Value						
	Drinking	Fishing	Recreation	Agriculture	Turag	Buri upper	Buri Lower	Dhaleswari	Lakhya upper	Lakhya Lower	Balu
DO, mg/l	4 (R)	5 (E)	4 (B)	5 (B)	< 1.0	0	< 1.0	> 5	< 1.0	2.0	< 1.0
BOD, mg/l	3 (R)	6 (B)	3 (B)	10 (B)	30	35-55	12	12	7	10	12-20
COD, mg/l	-	-	4 (B)	-	50-60	60-90	20	20	20	30-40	40-60
NH_3, mg/l	2 (R)	0.02 (B)	2 (B)	3 (B)	0.12-0.5	8-10	0.4 –0.5	0.02-0.04	0.25-0.5	3-7	8-10
NH_4^+, mg/l	2 (R)	1.2 (B)	-	15 (B)	10-18	16-17	7-10	1-2	2-3	2-6	4-12
NO_3^-, mg/l	10 (B)	40 (R)	-	-	3-7	1.5-1.8	2-3	2-2.5	2-3	2-3	2-3.5
PO_4^{---}, mg/l	6 (B)	-	-	-	1-4	0.4	0.4	0.1-0.3	1.5-2.0	0.2-4.5	3-4
Cr, mg/l	0.05 (B)	0.02 (R)	-	-	0.005-0.01	0.006-0.27	0.002-0.004	0.001-0.002	0.001-0.006	0.001	0.001-0.003
Pb, mg/l	0.10 (B)	0.10 (R)	-	-	0.001-0.01	0.001	0.001	0.001	0.005	0.001	0.001
Zn, mg/l	5 (B)	0.01 (R)			0.3-0.2	1-4	1-4	0.5-1.8	0.5-3	1.5-2.5	0.3-3
Hg, mg/l	0.001 (W)	0.0001 (C)	-	-	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Cl, mg/l	600 (B)	600 (B)	600 (B)	600 (B)	50-200	40-80	40-80	40-50	-	-	-
SS, mg/l	-	25 (B)	20 (B)	-	80-150	60-100	60-100	40-60	-	-	-
Alkalinity, mg/l	-	70-100 (B)	-	-	150-200	150-175	150-175	-	-	100-200	200
Coli, 1000 / 100 ml	0 (W)	-	-	10 (B)	80-200	8-160	8-160	3-20	0.6-2.5	5-3	8-203

Note:

i) Letter in the standard value column within parenthesis indicates countries or organization of setting Environmental Quality Standard (EQS) where B, C, E, R and W represent Bangladesh, Canada, European Union, Russia and World Health Organization, respectively.

ii) In the standard value column, DO express the minimum content while all other parameters represent maximum concentration level.

iii) The sign "–" indicates unavailability of values

iv) Buri upper and Buri lower represent the reachs of the Buriganga river from Hazaribag to Kamrangir Char and Chandnighat to Nabinagar, respectively.

v) Lakhya upper and lower represent the reaches of the Lakhya river from Rupganj to Siddhirganj and Siddhirganj to Kalagachia, respectively

4.4 Wastewater Quality

Wastewater quality data including flow rate is available in twelve sluices located on the Dhaka Integrated Flood Protection (DIFP) embankment as well as nine wastewater drains of Dhaka and Narayanganj city. The content of different parameters have been illustrated in the following paragraphs.

Wastewater Discharge

Wastewater flows in different outlets had been measured during sampling for water quality measurement and have been plotted in Figure 4.48. It is observed that major volume of wastewater is discharged through Dholai khal (around 5 m^3/s), Norai khal (around 7 m^3/s) and Kashipur khal (around 3 m^3/s).

Biochemical Oxygen Demand (BOD)

Biochemical oxygen demand (BOD_5 at 20 ^0C) measured in different wastewater outlets and campaigns has been plotted in Figure 4.47. Sluice no 3, 4, 5 and 11 discharge less pollutants having BOD_5 less than 200 mg/l. Sluice 7 and 8 discharge highly contaminated wastewater (maximum BOD_5 around 1400 mg/l) which carry effluents of tannery industries. BOD_5 around 500 mg/l is observed in the discharges of Sluice no. 9, 10 and Dholai khal as well as six wastewater drains of Narayanganj city. Norai Khal discharges comparatively less polluted water with BOD_5 around 60 mg/l.

Long-term records of water quality in the wastewater outlets are not sufficient. The available observations of BOD have been plotted for Sluice no. 7, 8, 9, 10, Dholai Khal and Norai Khal (Figure D.1 to D.6 in Appendix-D) since 1997, which represents a common tendency of increasing.

Chemical Oxygen Demand (COD)

Chemical oxygen demand (dichromate value) at Sluice no. 7 is very high around 2400 mg/l. Discharge of Sluice no. 8 shows highly pollutants at times. COD of Sluice no. 4, 5, 6, 11 and Norai khal is around 200 mg/l. COD ranging from 700 mg/l to 800 mg/l is generally observed in the discharges of Dholai khal and six wastewater drains of Narayanganj city. Measured COD of all the wastewater outlets have been shown in Figure 4.49.

BOD-COD Ratio

BOD-COD ratio in the Sluices of DIFP embankment and Norai Khal ranges from 0.2 to 0.6. The ratio is observed from 0.15 to 0.55 in the wastewater of Dholai khal. Six wastewater outlets of Narayanganj city show BOD-COD ratio ranging from 0.3 to 0.8. Figure 4.50 shows the ratios of BOD and COD in the discharges of wastewater outlets located surrounding the Dhaka city and Narayanganj city.

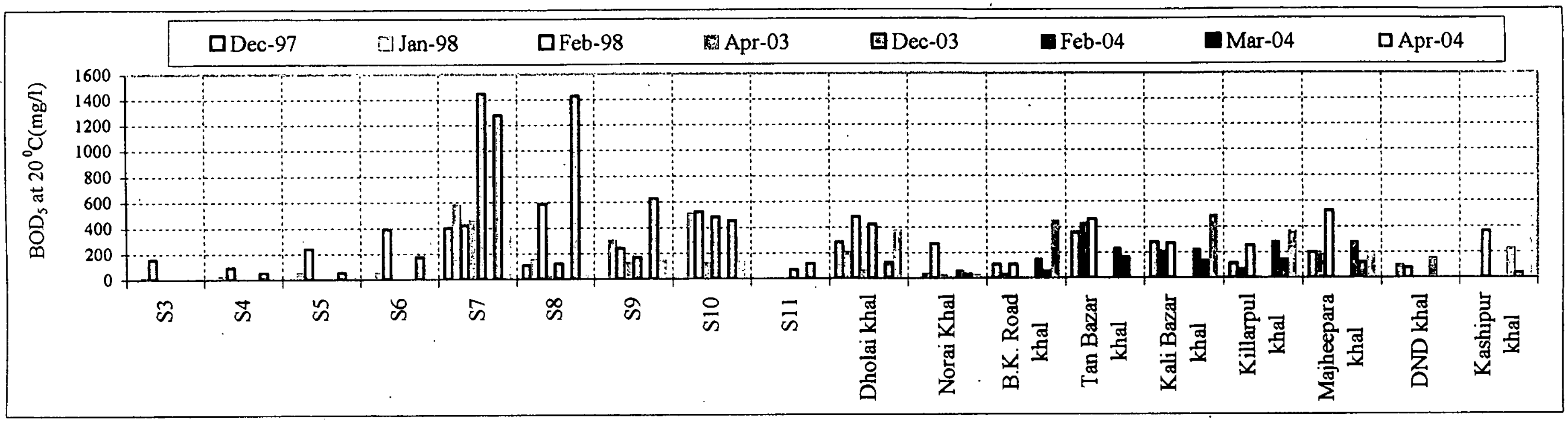

Figure 4.47 Biochemical Oxygen Demand (BOD5 at 20 ^{0}C) in wastewaters discharged into the peripheral river system (Data Source: Kamal, 1996; WSP International, 1998; IWM, 2005)

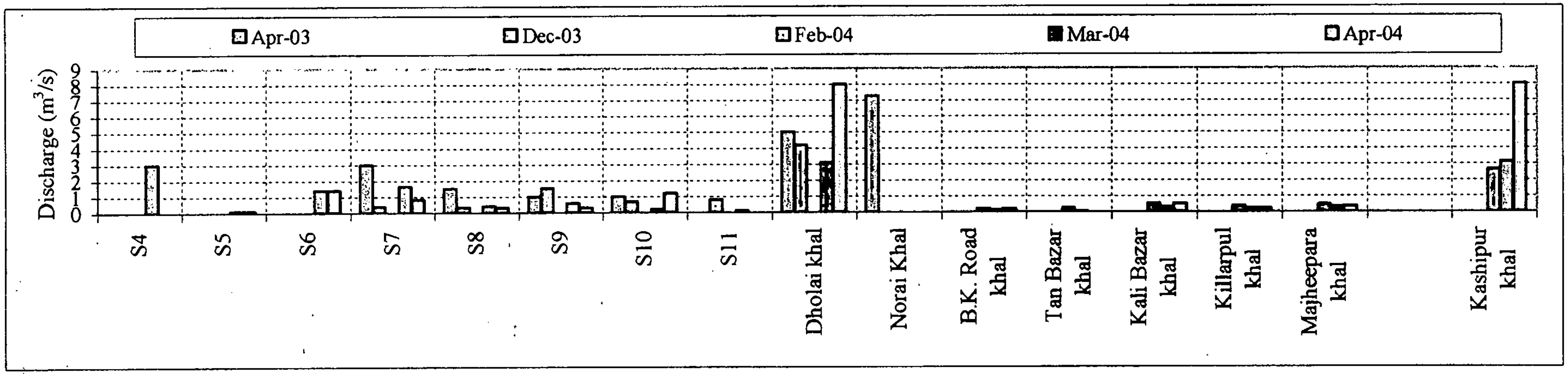

Figure 4.48 Measured wastewater flow discharged into the peripheral river system (Data Source: IWM, 2005)

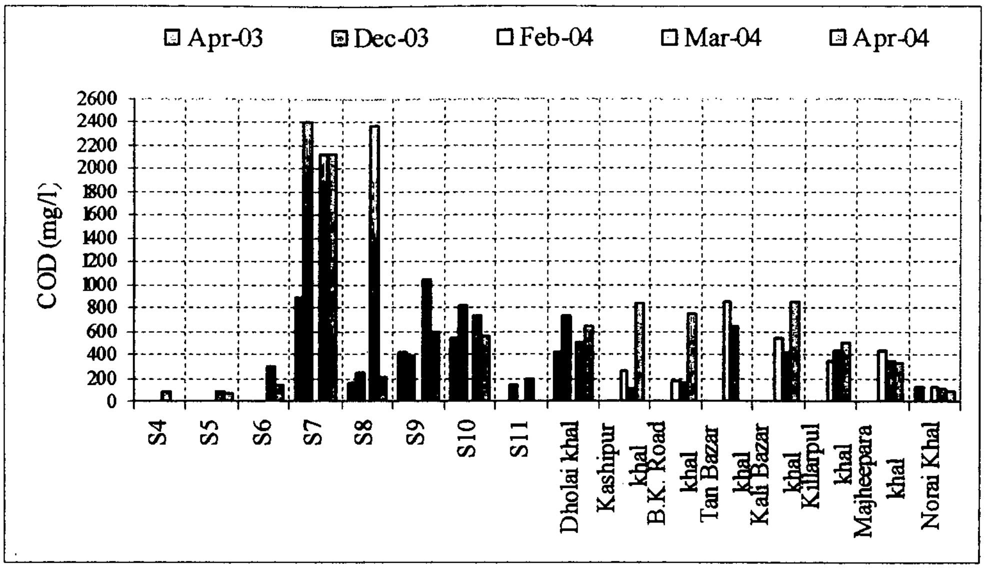

Figure 4.49 Observed chemical oxygen demands (COD, dichromate value) in the wastewater outlets (Data Source: IWM, 2005)

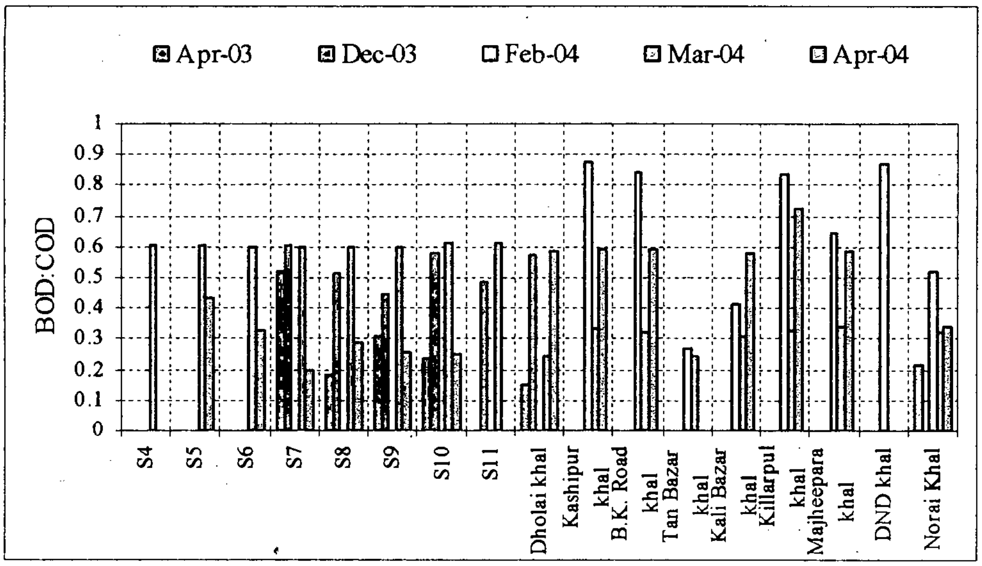

Figure 4.50 BOD-COD (BOD/COD) ratios in the wastewaters discharged through different wastewater Outlets of Dhaka and Narayan city.

Nitrogen (NH_3-N, NH_4^+-N and NO_3^--N)

Ammonia-Nitrogen (NH_3-N) concentrations measured in wastewaters of different outlets during 1997-98, 2003 and 2004 have been plotted in Figure D.7 to D.12 in Appendix-D. High ammonia content is observed during 1998. Ammonia content is remarkably low in the observations of 2003 and 2004. Significant ammonium content has been observed in the wastewaters. Sluice No. 7 and 8 as well as B. K. Road khal, Tanbazar khal and

Kalibazar khal discharge wastewater with high ammonium content (Figure 4.51). Nitrate content in the wastewaters is not too much (Figure 4.52).

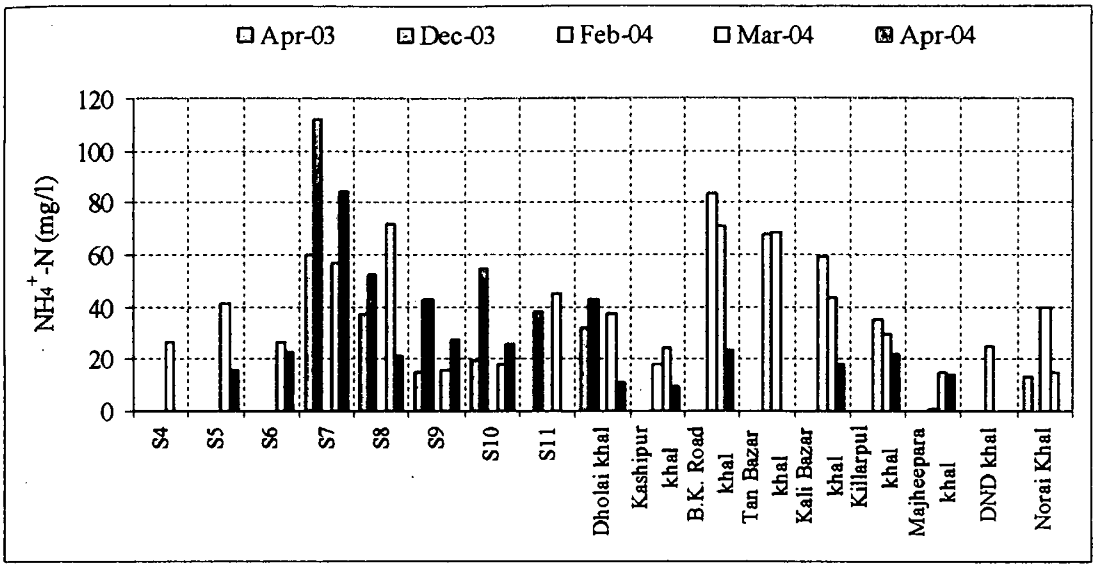

Figure 4.51 Ammonium-Nitrogen (NH_4^+-N) concentration in wastewater outlets (Data Source: IWM, 2005)

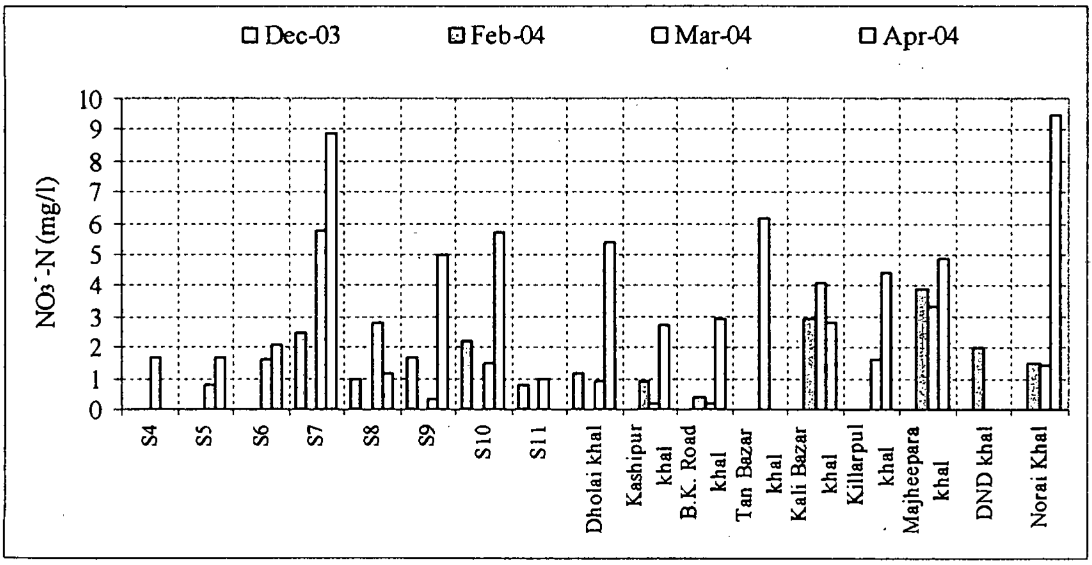

Figure 4.52 Nitrate-Nitrogen (NO_3^--N) concentration in wastewater outlets (Data Source: IWM, 2005)

Phosphate (PO_4^{3-})

Phosphate content in wastewater has been plotted in Figure 4.51. It is observed that phosphate content during 2004 is much lower than that measured during 1998. This may be occurred due to dilution resulting from pre-monsoon rainfall before sampling.

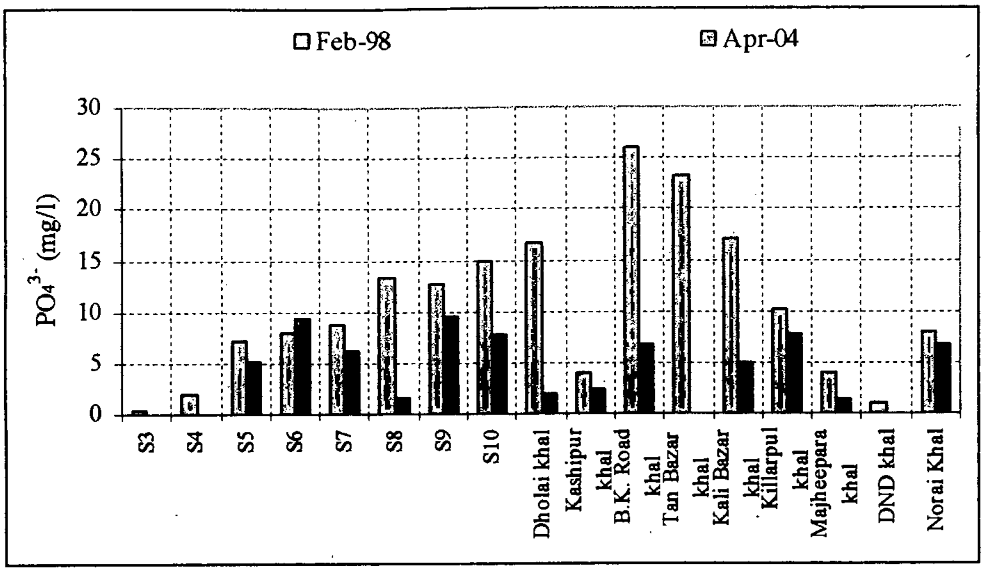

Figure 4.53 Phosphate (PO_4^{3-}) concentration in wastewater outlets (Data Source: WSP International, 1998; IWM, 2005)

Heavy Metals (Chromium, Lead, Mercury, Zinc)

Lead (Pb)

Measured lead content in wastewaters has been shown in Figure 4.54. Significant lead content is observed in the discharges of Sluice No. 7, 8, 9, 10 as well as Dholai khal, Killarpul khal and Kashipur Khal.

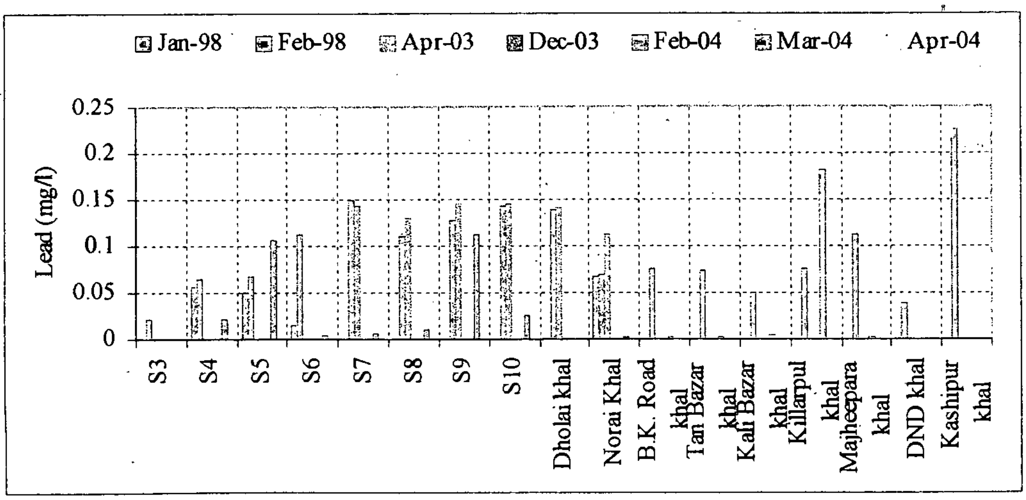

Figure 4.54 Lead (Pb) concentrations in the wastewater outlets (Data Source: WSP International, 1998; IWM, 2005)

Zinc (Zn)

Recent measurement of zinc is not available. Observed zinc content in wastewater during 1998 has been plotted in Figure 4.55. Average zinc content rangers from 2 mg/l to 5 mg/l in the wastewaters except at Dholai khal and Kashipur where the same is less than 0.20 mg/l.

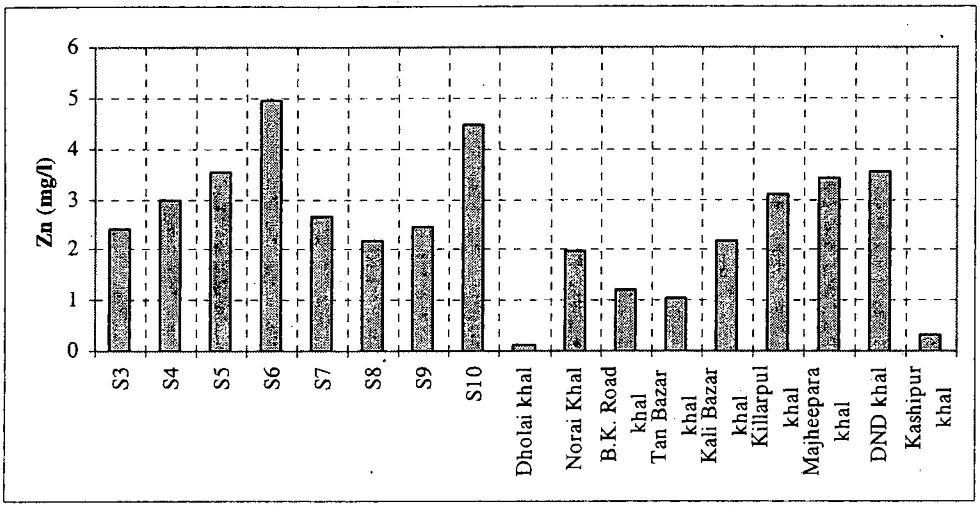

Figure 4.55 Zinc (Zn) concentrations in the wastewater outlets

Chromium (Cr)

High chromium content is observed in the wastewaters discharged through the Sluice No. 7 due to addition of effluents from tannery industries (Figure 4.56a). Sluice No. 4, 5, 8 and Dholai khal also discharge significant chromium. Chromium content in wastewaters of the remaining outlets is not too much (Figure 4.56b).

4.5 Estimation of Pollution Loads

Pollution loads contributed by the points sources, illustrated in chapter 3, have been calculated in wet method for four campaigns during 2003 and 2004. Wastewater discharge period has been assumed to be 12 hours out of 24 hours considering tidal influence of the receiving rivers as well as water consumption practice. The expression used in computation of pollution load in Wet Method is as following:

$$\begin{aligned}\text{Pollution Load} &= \text{Concentration (mg/l)} \times \text{Flow } (m^3/s) \times \text{Flow time}\\ &= \text{Conc. (mg/l)} \times Q\ (m^3/s) \times 12.0\text{ h}\\ &= \text{Conc. } (gm/m^3) / (1000\text{ gm/Kg}) \times Q\ (m^3/s) \times (3600\text{ s/h}) \times 12.0\text{ (h/d)}\\ &= \text{Load (Kg/d)}\end{aligned}$$

Pgla Sewage Treatment Plant Authority routinely measures biological oxygen demand (BOD) and also records average volume of daily discharge. BOD load has been computed from the measured data of PSTP authority and shown in Table 4.2.

Table 4.2 BOD Load discharged into the Buriganga river from PSTP

Date	BOD_5 (mg/l)	Flow rate (m^3/d)		Average Flow (m^3/d)	BOD_5 Load (Kg/d)
		Maximum	Minimum		
Mar98	240	46440	38700	42570	10216.80
Apr98	240	52200	39960	46080	11059.20
May98	60	56520	41328	48924	2935.44
Jun98	20	49680	40860	45270	905.40
Apr03	150	31000	15000	23000	3450.00
Dec03	170	29952	15000	22476	3820.92
Feb04	240	27360	16338	21849	5243.76
Mar04	200	29016	14028	21522	4304.40
Apr04	200	39780	19278	29529	5905.80

Pollution loads in the other wastewater outlets located around the Dhaka city and Narayanganj city have been computed from measured data of IWM and shown in Table 4.3

Table 4.3 Pollution loads discharged through wastewaters generated within Dhaka and Narayanganj city (Point sources) (Estimation based on a single measurement in a day).

Station	Date of Collection	Load (kg/d)							
		BOD_5	COD	NH_3-N	NH_4-N	NO_3-N	PO_4	Cr	Pb
S4	14-Mar-04	6718	11073	75.3	3284	211.5	N. A.	27.12	2.74
S5	14-Mar-04	225	372	1.4	177	3.5	N. A.	0.80	0.46
S5	27-Apr-04	130	298	1.1	66	7.3	22.25	0.00	*
S6	15-Mar-04	10584	17600	7.3	1595	96.8	N. A.	0.27	0.29
S6	27-Apr-04	2722	8346	17.3	1344	127.0	568.51	0.03	*
S7	27-Apr-03	25834	49758	66.8	3359	N. A.	N. A.	83.68	8.03
S7	31-Dec-03	24116	39950	425.8	1861	41.6	N. A.	372.89	80.33
S7	15-Mar-04	90685	150906	132.8	4012	410.9	N. A.	515.77	0.40
S7	27-Apr-04	15055	75595	49.5	2979	315.3	221.40	61.85	*
S8	27-Apr-03	544	2994	8.9	725	N. A.	N. A.	0.82	2.55
S8	31-Dec-03	1913	3732	5.8	815	15.6	N. A.	2.64	*
S8	15-Mar-04	25855	43074	45.0	1298	50.8	N. A.	479.91	0.18
S8	27-Apr-04	778	2657	3.7	272	15.6	20.09	0.62	*
S9	27-Apr-03	5616	18101	1.7	646	N. A.	N. A.	1.64	6.31
S9	31-Dec-03	3672	8208	6.0	924	36.7	N. A.	1.62	*
S9	16-Mar-04	16200	27009	1.4	413	7.8	N. A.	2.20	2.90
S9	27-Apr-04	2074	8087	2.2	378	69.1	130.64	0.19	*
S10	27-Apr-03	5400	23112	2.2	829	N. A.	N. A.	1.47	6.31
S10	31-Dec-03	13893	23879	6.9	1577	63.7	N. A.	2.37	*
S10	16-Mar-04	4277	7023	0.5	171	14.3	N. A.	0.31	0.26
S10	27-Apr-04	7258	29290	4.4	1330	295.5	396.58	0.58	*
S11	31-Dec-03	2350	4804	5.9	1324	27.6	N. A.	1.97	*
S11	16-Mar-04	497	812	1.0	194	4.3	N. A.	0.02	0.05
Dholai khal	27-Apr-03	14040	91800	21.6	6890	N. A.	N. A.	4.75	30.67
Dholai khal	31-Dec-03	72576	127008	32.8	7361	207.4	N. A.	69.12	*
Dholai khal	27-Mar-04	18900	77112	19.7	5613	136.1	N. A.	0.73	**
Dholai khal	23-Apr-04	65664	112666	6.9	1885	933.1	357.70	2.76	*
Norai Khal	29-Apr-03	8661	39681	44.1	4129	N. A.	N. A.	0.47	35.90
Norai Khal	25-Feb-04	17963	34728	128.7	11867	449.1	N. A.	5.99	*

Station	Date of Collection	Load (kg/d)							
		BOD_5	COD	NH_3-N	NH_4-N	NO_3-N	PO_4	Cr	Pb
Norai Khal	23-Mar-04	16934	52920	58.2	7880	740.9	N. A.	1.96	0.66
Norai Khal	14-Apr-04	24157	70862	15170.9	129	7649.9	5515.95	*	*
B.K. Road khal	13-Feb-04	1296	1538	5.7	718	3.5	N. A.	0.03	0.02
B.K. Road khal	27-Mar-04	324	998	4.0	459	1.3	N. A.	**	**
B.K. Road khal	23-Apr-04	3888	6532	1.8	203	25.1	58.32	0.02	*
Tan Bazar khal	13-Feb-04	2538	9299	2.8	732	224.1	N. A.	0.05	0.03
Tan Bazar khal	27-Mar-04	346	1408	0.3	149	13.4	N. A.	0.00	**
Kali Bazar khal	13-Feb-04	2916	6998	4.4	771	37.6	N. A.	0.06	0.06
Kali Bazar khal	27-Mar-04	1685	5495	1.9	565	53.1	N. A.	0.00	**
Kali Bazar khal	23-Apr-04	4234	7344	0.5	155	24.2	43.20	0.01	0.01
Killarpul khal	13-Feb-04	4309	5171	2903.0	530	0.0	N. A.	0.06	2.77
Killarpul khal	27-Mar-04	1210	3698	0.9	258	13.8	N. A.	0.02	*
Killarpul khal	23-Apr-04	3357	4645	0.6	201	39.9	70.76	0.03	*
Majheepara khal	13-Feb-04	5443	8456	35.5	16	75.8	N. A.	0.45	0.06
Majheepara khal	27-Mar-04	1555	4523	119.9	194	42.8	N. A.	0.05	*
Majheepara khal	23-Apr-04	2873	4929	131.2	213	74.1	21.02	0.06	*
DND khal	13-Feb-04	N. F.	N. F.	N. F.	N. F.	N. F.	N. F.	0.00	*
Kashipur khal	13-Feb-04	9837	11205	93.7	763	38.5	N. A.	0.17	*
Kashipur khal	27-Mar-04	4687	13928	41.5	3206	26.8	N. A.	2.41	**
Kashipur khal	23-Apr-04	86400	145843	20.7	1569	466.6	411.26	*	*

Note: N. F. indicates no flow in the drain
N. A. indicates parameter has not been tested
* indicates concentrations observed less than 0.001 mg/l
** indicates no trace found in the laboratory testing

It is very important to assess the computed pollution loads in the table above where some large figures are observed in the measurements during March and April 2004. There are some sensible background behind this abnormalities. Some high figures of pollution loads are seen in Mar-04 at Sluice no. 6, 7,8 and 9 (located in the Hazaribag area) which was occurred due to excessive tannery processing just after Eid-ul-Azha. Heavy rainfall occurred during early April 2004 which reduced pollution loads in the Sluices No. 5, 6, 7, 8 and 9 due to retention of wastewater in the pocket like ditches inside the embankment. The occurrence of rainfall also increased pollution load in Kashipur Khal, Norai Khal and Dholai Khal enormously due to washout of deposited wastes in residential areas. Therefore, pollution loads observed during Apr-03 and Dec-03 are more justified in overall consideration. Although it is thought that DND Khal drains wastewater from DND project areas but no flow was observed on 13th February' 04 rather river water was being pumped into the project area for irrigation. Therefore, contribution of DND Khal has been excluded in the computation of pollution load. Pollution loads added into the different reaches of the river system through different wastewater outlets of Dhaka and Narayanganj city are as shown in Table 4.4.

Wastewater flow and quality do not maintain uniformity throughout a day rather vary highly with hours. The pollution loads estimated in the above table is based on a single measurements in a day. Therefore, it is very crude estimation and the calculated values cannot be represented the actual daily pollution load discharged into the peripheral river system. However, we can get a tentative idea about the volume of pollution load and relative contributions of the different wastewater drains.

Table 4.4 Pollution Load contributed into the peripheral rivers through different point sources i.e. wastewater drains (Estimation based on a single measurement in a day)

Name River	Point Sources	Time	Load (kg/d)							
			BOD_5	COD	NH_3-N	NH_4-N	NO_3-N	PO_4	Cr	Pb
Turag	S4, S5, S6, S7	Feb98	34890	N.A.	4865	N.A.	N.A.	745	753.75	19.5
		Apr 03	43361	78802	150.8	8415	N.A.	N.A.	111.87	11.52
		Dec 03	41644	68994	509.8	6917	353.3	N.A.	401.08	83.82
		Mar 04	108213	179950	216.8	9068	722.6	N.A.	543.97	3.89
		Apr 04	18606	85393	76	4731	471.7	812	64.71	*
Buriganga	S8, S9, S10, S11, Dholai Khal,	Feb98	41100	N.A.	4500	N.A.	N.A.	1430	8.3	12.75
		Apr 03	26097	136819	35	9285	N.A.	N.A.	8.70	45.88
		Dec 03	94404	167631	57	12002	351	N.A.	77.73	*
		Mar 04	65729	155030	67.5	7689	213.2	N.A.	483.17	3.39
		Apr 04	76270	153511	18	4060	1317.6	905	4.19	*
Dhaleswari	Kashipur K	Feb98	30000	N.A.	870	N.A.	N.A.	500	3	30
		Feb 04	9837	11205	93.7	763	38.5	N.A.	0.17	*
		Mar 04	4687	13928	41	3206	26.8	N.A.	2.41	**
		Apr 04	86400	145843	20.7	1569	466.6	411	*	*
Lakhya	Majheepara K, Killarpul K, Tanbazar K, B.K. Road K, Kalibazar K	Feb98	19125	N.A.	1340	N.A.	N.A.	565	7.51	5.04
		Feb 04	16502	31463	2951	2766	22527	N.A.	0.66	2.94
		Mar 04	5119	16122	127	1626	124.4	N.A.	0.07	*
		Apr 04	14697	24858	135	921	176.6	193	0.11	*
Balu	Norai Khal	Feb98	75300	N.A.	7700	N.A.	N.A.	2200	8	40
		Apr 03	8661	39681	44	4129	N.A.	N.A.	0.47	35.90
		Feb 04	17963	34728	128.7	11867	449.1	N.A.	5.99	*
		Mar 04	16934	52920	58.2	7880	740.9	N.A.	1.96	0.66
		Apr 04	24157	70862	15171	129	7650	5516	*	*

Note:

i) Observations at S4, S5, S6 are not available during April 03 and December 03. Therefore, values from measurements of March 04 have been taken to compute pollution loads of the Turag river.

ii) Observations of S11 are not available during April 03 and April 04. Value from measurement of March 04 has been taken to compute loads for the Buriganga river.

iii) Load contributed by PSTP into the Buriganga is not included in the Table

iv) Loads contributed by non-point sources are not included in the table

v) Values in shaded areas are provisional and the authority of the data has imposed limitation to use

vi) Measurements of NH_3, PO_4, Cr and Pb are not available at PSTP outfall and the same have been calculated using ratios with BOD observed during 1998.

vii) "N. A." indicates that observation is no available

viii) " * " indicates that observed concentration is less than 0.001 mg/l

ix) " ** " indicates that no trace found during testing of parameter

Besides the pollution loads specified in the Table 4.4, some pollution load is added into the river system from non-point sources. Non-point pollution loads had been computed in a previous study (WSP, 1998) and are as shown in Table 4.5 given below.

Table 4.5 Pollution Loads contributed by non-point sources estimated using dry-method (WSP, 1998)

Discharge into	Non-Point Sources	Load (kg/d)							
		BOD_5	COD	NH_3-N	NH_4-N	NO_3-N	PO_4	Cr	Pb
Buriganga	City drains	8000	N.A	840	N.A	N.A	250	5.0	3.5
Lakhya	Lakhya L/B	4150	N.A	430	N.A	N.A	140	1.0	1.5
Tongi Khal	Tongi	5160	N.A	540	N.A	N.A	170	1.5	2.0
Dhaleswari	Dhaleswari L/B	2800	N.A	290	N.A	N.A	100	0.5	0.90

Total pollution loads discharged into the peripheral river system around Dhaka and Narayanganj city through both point and non-point sources have been summarized in Table 4.6.

Table 4.6 Pollution loads added into the different river reaches through both point sources (wastewater drains) and non-point sources.

Name of River reach	Observation Period	Discharged Pollution Load (kg/d)				
		BOD_5	NH_3-N	PO_4	Cr	Pb
Tongi Khal	Feb-98	5860	560	173	3	4
Turag river	Apr-95	27113	N. A.	N. A.	N. A.	N. A.
	Feb-98	34890	4865	745	754	19
	Apr-03	43361	150.8	N. A.	112	11.5
	Dec-03	41644	510	N. A.	401	84
	Mar-04	108213	217	N. A.	544	4
	Apr-04	18606	76	812	64.7	*
Buriganga river	Apr-95	45388	N. A.	N. A.	N. A.	N. A.
	Feb-98	58000	5762	2333	17	18
	Apr-03	37547	1038	N. A.	15	50
	Dec-03	106225	1078	N. A.	84	*
	Mar-04	78033	1111	N. A.	490	8
	Apr-04	90176	1137	1582	12	*
Dhaleswari river	Apr-95	363	N. A.	N. A.	N. A.	N. A.
	Feb-98	32800	1160	600	3	31
	Feb-04	28882	538	N. A.	1	*
	Mar-04	12637	384	N. A.	1	*
	Apr-04	89200	311	511	*	*
Lakhya river	Feb-98	23275	1774	707	9	7
	Feb-04	20652	3381	N. A.	2	4.4
	Mar-04	9269	557	N. A.	1	*
	Apr-04	18847	565	333	1	*
Balu river	Feb-98	75300	7700	2195	8	40
	Apr-03	8661	44	N. A.	0.47	36
	Feb-04	17963	129	N. A.	6	*
	Mar-04	16934	58	N. A.	2	0.66
	Apr-04	24157	15171	5516	*	*
Peripheral River system	Apr-95	87385	N. A.	N. A.	N. A.	N. A.
	Feb-98	230125	21821	6753	794	119
	Mar-04	230946	2887	N. A.	1041	16.6
	Apr-04	246846	17820	8927	*	*

PTO

N.B

Explanation of " N. A." and " * " are same as mentioned above

Pollution load of Tongi area calculated by dry method has been used in the recent year without any modification due to unavailability of observations

Point loads are estimated based on a single measurement in a day

The estimated pollution loads discharged into the peripheral river system around Dhaka and Narayanganj city can be summarized as below:

Type of Load	**Pollution Load Volume**
BOD_5	230 ton/day
Ammonia (NH_3)	5 ton/day
Phosphate (PO_4)	8 ton/day
Chromium (Cr)	0.50 ton/day
Lead (Pb)	0.10 ton/day

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The study has assessed water quality in the peripheral rivers around the Dhaka city with respect to dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), ammonia (NH_3), ammonium (NH_4^+), nitrate (NO_3^-), phosphate (PO_4^{3-}), chromium (Cr), mercury (Hg), lead (Pb), alkalinity, chloride (Cl), coliforms (F.C. and T.C.) and solids.

This study has scrutinized the water quality in the river system in dry period due to unavailability of round the year's data. Analysis of water quality data from December to April reveals that river water deteriorates from January, reaches the worst condition in February and March and then start to improve. Suspended solids and Turbidity remain high in the flood seasons.

It is observed that required dissolved oxygen (DO) for sustaining aquatic lives (5 mg/l) prevails only in the Dhaleswari river (downstream of Nabinagar to Kalagachia) and in the short downstream reach of Lakhya river (from Mashinabanda to Kalagachia) throughout the year. The rest of the river reaches maintain lower DO level usually less than or around 1 mg/l in the dry period. Dissolved oxygen content in the dry season is gradually reducing in the Turag river, Buriganga river and Balu river. Insignificant diurnal variation of DO is observed in the Dhaleswari and Lakhaya river.

High biological oxygen demand (BOD_5 at 20 ^{0}C) is observed in the Turag river and upper reach of the Buriganga river. Chemical oxygen demands (COD) of the Tongi Khal, Turag river, Balu river and Buriganga river (Hazaribag to Keraniganj) are quite high.

Excessive Ammonia-Nitrogen (NH_3-N) content has been recorded in the river reaches from Kamrangir char to Keraniganj in the Buriganga river, from Demra to Siddhirganj in the Lakhya river and in the Balu river. Ammonia-Nitrogen (NH_3-N) content is low in the Turag river, Buriganga river (from Pagla to Fatulla), Dhaleswari river, Lakhya river (from Gandharbapur to Rupganj) and Tongi Khal.

NO_3^--N concentration is below 10 mg/l (Bangladesh guide line value) in the entire river system except at Katashur in the Turag river. PO_4^{---} concentration is below 6 mg/l (Bangladesh Guide line value) in the entire river system. Chromium concentration in the river system is quite low compared to the Bangladesh drinking water standard (0.050 mg/l) except in a short reach of the Buriganga river at Hazaribag where the concentration exceeds 0.25 mg/l. The maximum Lead concentration in the entire river system is below the permissible limit specified in Bangladesh drinking standard i.e. 0.10 mg/l. The Mercury content in the entire river system is too low even below the detection limit. Level of zinc in the river system is below maximum allowable limit of Bangladesh drinking standard (5 mg/l) but alarming for fisheries.

Alkalinity existing in the peripheral river system is bicarbonate type and varies from 175 to 200 mg/l. pH in the entire river system is generally less than 8.0. Average chloride content in the river system is around 50 mg/l in the dry period. High concentration of Colliform is observed in the entire river reaches. Suspended solid and total solid content in the river system is around 50 mg/l and 400 mg/l, respectively. Suspended solid content usually increases in the flood season.

Naturally, flow and quality of wastewater vary with hours. The pollution loads estimated in this study discharged through different wastewater drains on the basis of single measurement in a day. Thus, the estimated loads do not represent the actual daily pollution load discharged into the peripheral river system rather it gives a general idea about volume of load and relative contribution of different wastewater drains.

5.2 Recommendation

There is no observation of water quality in the river system on February of the recent year i.e. 2004. Therefore, a complete observation from December to April is essential for better understanding of actual condition of water quality in the river system.

Dissolved Oxygen (DO) data measured so far by different authorities is available only for eight hours or less in a day, which is insufficient to understand the diurnal variation. Continuous measurement of DO throughout whole day or at least 12 hours (from 6:00 am to 6:00 pm) will help to understand the complete diurnal variation.

The rate of wastewater flow varies highly and even with hours. Measurement of wastewater flows through different outlets throughout whole day is essential for at least one campaign to compute actual volume of wastewater discharged into the rivers.

Wastewater quality data so far available is insufficient for estimation of pollution load discharged into the river system. Intensive measurements are required to understand the exact pollution load that is generated in the Dhaka city and discharged into the peripheral rivers. As Norai Khal, Dholai Khal, Sluice No. 6, 7 & 8 discharge most of the pollution loads, data collection in closer frequency at these station may help in proper load estimation.

There is no regular water quality monitoring station on the Tongi Khal. Water quality monitoring stations are required in the Tongi Khal, upper reaches of the Turag river and Balu river for better understanding of the water quality.

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APPENDIX-A

Water Quality Data in Stream and Wastewater Outlets

Table A.1 Measured Dissloved Oxygen Data (Kamal,1996; WSP International, 1998; IWM, 2005)

Station	Date&Time	Temp ^{0}C	DO (mg/L)	Station	Date&Time	Temp ^{0}C	DO (mg/L)	Station	Date&Time	Temp ^{0}C	DO (mg/L)
Turag-2	1/18/98 9:40	19.3	2.8	Turag-1	1/18/98 15:02	19.5	4.6	Buri-1	12/19/94 16:20	21.6	5.6
Garanchandbari	1/18/98 10:50	19.4	3.7	Harirampur	2/16/98 10:10	22.5	1.9	Mirpur Bridge	12/19/94 17:00	21.5	5.8
Turag River	1/18/98 11:37	19.4	3	Turag River	2/16/98 11:34	22.9	2	Turag River	2/14/95 8:10	22.7	1.1
	1/18/98 12:27	19.3	3		2/16/98 12:23	23.1	1.8		2/14/95 9:25	22.6	0.3
	1/18/98 13:40	19.3	4.4		2/16/98 13:13	23.3	1.7		2/14/95 10:25	22.6	0.3
	1/18/98 14:35	19.4	4.5		2/16/98 14:04	23.3	1.7		2/14/95 11:25	22.7	0.3
	1/18/98 15:25	19.5	3.5		2/16/98 14:55	23.6	1.6		2/14/95 12:35	23	0.4
	2/16/98 9:45	22.5	1.7		2/16/98 15:42	23.6	1.7		2/14/95 13:30	23.4	0.5
	2/16/98 10:40	22.6	1.7		4/22/03 13:30	29.4	5.6		2/14/95 14:20	23.4	0.5
	2/16/98 12:05	22.9	1		3/14/04 10:30	26.7	1.21		2/14/95 15:15	23.6	0.8
	2/16/98 12:53	23.1	0.8		3/14/04 11:30	27.3	2.4		2/14/95 16:00	23.7	1
	2/16/98 13:42	23.1	0.7		3/14/04 12:40	27.4	2.5		4/19/95 8:00	30	1
	2/16/98 14:31	23.4	0.9		3/14/04 13:30	27.6	2.9		4/19/95 9:00	30.1	1.8
	2/16/98 15:17	23.4	0.9		3/14/04 14:10	27.8	2.6		4/19/95 10:12	30.2	1.3
	2/16/98 16:06	23.5	1.2		3/14/04 15:00	27.6	2.3		4/19/95 11:05	30.3	2
	3/14/04 10:05	26.6	1		3/14/04 16:00	27.6	1.2		4/19/95 12:03	30.5	2.4
	3/14/04 11:00	26.7	1		4/3/04 10:50	29	1.2		4/19/95 13:08	30.6	2.5
	3/14/04 12:05	26.9	1		4/3/04 11:45	29.4	4.4		4/19/95 14:05	30.9	3.3
	3/14/04 13:10	27.3	1.3		4/3/04 12:32	29.6	5.3		4/19/95 15:00	30.9	3.4
	3/14/04 14:40	26.9	1.23		4/3/04 13:17	29.7	4.3		4/19/95 16:55	31.1	4.4
	3/14/04 15:40	26.7	0.8		4/3/04 13:55	29.9	6.6		4/19/95 17:45	31.4	5
	4/3/04 11:20	29.4	1.5		4/3/04 14:40	30.1	6		12/17/97 8:50	20.8	5.9
	4/3/04 12:10	29.3	1.2		4/3/04 15:37	30	6.5		12/17/97 10:00	20.8	6.4
	4/3/04 12:53	29.4	1		4/3/04 16:40	29.7	4.6		12/17/97 11:07	20.8	6.3
	4/3/04 14:15	29.6	1.6	Buri-1	12/19/94 8:10	20.8	6.1		12/17/97 12:31	20.8	5.6
	4/3/04 15:00	29.6	1.6	Mirpur Bridge	12/19/94 9:25	20.8	5.8		12/17/97 13:40	21.2	5.2
	4/3/04 16:10	29.7	2.2	Turag River	12/19/94 10:25	21	5.2		12/17/97 14:37	21	5.5
Turag-1	1/18/98 10:10	19.3	3.2		12/19/94 11:30	21.2	4.8		12/17/97 15:32	21.1	5.5
Harirampur	1/18/98 11:13	19.4	3		12/19/94 12:30	21.3	4.6		12/17/97 16:35	21.2	5.7
Turag River	1/18/98 12:01	19.5	3.3		12/19/94 13:30	21.4	4.7		1/19/98 9:20	19	6
	1/18/98 12:47	19.5	3.1		12/19/94 14:40	21.5	5		1/19/98 10:20	19.1	5.7
	1/18/98 14:00	19.5	4.6		12/19/94 15:30	21.6	5.4		1/19/98 11:32	19.1	6.4

Table A.1 continued

Station	Date&Time	Temp ^{0}C	DO (mg/L)
Buri-1	1/19/98 12:30	19.3	5.8
Mirpur Bridge	1/19/98 13:41	19.4	5.4
Turag River	1/19/98 14:30	19.5	5.1
	1/19/98 15:25	19.4	5
	2/17/98 9:40	23.1	1.9
	2/17/98 10:55	23.2	1.5
	2/17/98 11:58	23.5	1
	2/17/98 13:12	23.6	0.7
	2/17/98 14:15	23.8	0.7
	2/17/98 15:06	24	1.1
	2/17/98 15:55	23.8	0.8
	2/17/98 16:48	23.8	0.8
	4/23/03 10:30	28.2	3.7
	3/15/04 9:00	26.7	0.16
	3/15/04 9:50	26.8	0.2
	3/15/04 11:00	27	1.02
	3/15/04 12:10	27.8	2.08
	3/15/04 13:05	27.7	2.2
	3/15/04 14:00	28.1	4.3
	3/15/04 14:50	28.4	5.2
	3/15/04 16:00	27.6	1.2
	4/4/04 9:00	28.9	0.12
	4/4/04 10:02	29	0.11
	4/4/04 10:55	29.1	0.14
	4/4/04 11:50	29.2	0.2
	4/4/04 12:42	29.4	0.48
	4/4/04 14:00	29.8	0.9
	4/4/04 14:45	29.9	1.6
	4/4/04 15:50	30.1	1.9
Buri-2	12/19/94 9:00	21	3.6
Katashur	12/19/94 10:00	21.1	3.7
Turag River	12/19/94 11:05	21.3	3.4
Buri-2	12/19/94 12:00	21.4	2.6
Katashur	12/19/94 13:00	21.6	3.5
Turag River	12/19/94 14:00	21.6	3.8
	12/19/94 15:05	21.6	4.1
	12/19/94 15:55	21.8	4.5
	2/14/95 9:00	22.3	0.3
	2/14/95 10:00	22.3	0.3
	2/14/95 10:55	22.3	0.1
	2/14/95 12:00	22.7	0.3
	2/14/95 13:00	22.8	0.3
	2/14/95 13:55	23.1	0.5
	2/14/95 14:45	23.3	0.7
	2/14/95 15:40	23.3	0.5
	2/14/95 8:35	30	1.6
	4/19/95 9:48	30.3	1.9
	4/19/95 10:41	30.2	1.8
	4/19/95 11:36	30.3	1.8
	4/19/95 12:40	30.5	2.3
	4/19/95 13:40	31.2	4.2
	4/19/95 14:30	31.1	4.4
	4/19/95 15:22	31.3	4.6
	4/19/95 16:20	31.3	8.2
	12/17/97 9:25	20.7	5.2
	12/17/97 10:37	20.9	5
	12/17/97 12:02	21.1	4.5
	12/17/97 13:03	21.3	4.3
	12/17/97 14:12	21.4	4.5
	12/17/97 15:03	21.6	5
	12/17/97 16:00	21.4	5
	1/19/98 9:42	19.2	4.4
	1/19/98 11:02	19.2	5.5
	1/19/98 12:05	19.3	4.8
Buri-2	1/19/98 13:06	19.3	4.6
Katashur	1/19/98 14:07	19.5	2.8
Turag River	1/19/98 14:58	19.6	2.6
	2/17/98 10:25	23.2	0.3
	2/17/98 11:35	23.4	0.6
	2/17/98 12:30	23.4	0.7
	2/17/98 13:40	23.5	0.3
	2/17/98 14:41	23.6	0.3
	2/17/98 15:32	23.8	0.9
	2/17/98 16:21	23.9	1.2
	4/23/03 11:30	29.1	1.5
	3/15/04 9:25	26.2	0.05
	3/15/04 10:30	26.6	0.06
	3/15/04 11:35	26.3	0.05
	3/15/04 12:35	26.4	0.06
	3/15/04 14:25	28.4	0.2
	3/15/04 15:25	26.6	0.06
	4/4/04 9:04	28.9	0.15
	4/4/04 10:30	29	0.13
	4/4/04 11:20	29.1	0.15
	4/4/04 12:20	29.4	0.48
	4/4/04 13:20	29.4	0.3
	4/4/04 15:16	29.9	1.4
Buri-3	12/26/94 8:20	20.6	2.7
Kamrangir Char	12/26/94 9:40	20.7	2.9
Buriganga	12/26/94 10:50	20.8	2.7
	12/26/94 11:45	20.8	2.9
	12/26/94 12:45	21.3	3
	12/26/94 13:45	21.3	3.1
	12/26/94 14:50	21.3	3.1
	2/16/95 9:35	21.8	0.4
	2/16/95 11:10	22	0.3

Table A.1 continued

Station	Date&Time	Temp ^0C	DO (mg/L)
Buri-3	2/16/95 12:20	21.8	0.8
Kamrangir Char	2/16/95 13:45	22	2
Buriganga	2/16/95 14:55	22.4	2.8
	4/20/95 8:50	30.4	1.7
	4/20/95 10:10	30.6	2.5
	4/20/95 11:10	30.8	3.9
	4/20/95 12:20	30.6	3.8
	4/20/95 13:30	31.4	5.2
	4/20/95 14:50	30.7	5.3
	4/20/95 16:00	30.6	4.3
	12/18/97 9:20	21.3	2.4
	12/18/97 10:34	21.5	2.4
	12/18/97 11:52	21.6	2
	12/18/97 13:05	21.7	2.1
	12/18/97 14:32	21.9	2.2
	12/18/97 15:45	21.8	2.4
	1/20/98 10:05	19.3	0.8
	1/20/98 11:27	19.4	0.8
	1/20/98 12:32	19.5	0.7
	1/20/98 13:45	19.5	0.7
	1/20/98 14:58	19.5	1.1
	2/18/98 10:10	22.8	0.8
	2/18/98 11:25	22.8	0.6
	2/18/98 12:59	22.8	0.8
	2/18/98 14:12	22.8	0.6
	2/18/98 15:26	22.7	0.7
	4/26/03 9:30	29.9	0.2
	3/16/04 10:00	26.1	0.12
	3/16/04 11:00	26.8	0.07
	3/16/04 12:25	26.7	0.12
	3/16/04 14:00	27.4	0.11
	3/16/04 15:00	27.4	0.07

Station	Date&Time	Temp ^0C	DO (mg/L)
Buri-3	4/5/04 10:08	28.6	0.13
Kamrangir Char	4/5/04 11:00	28.7	0.1
Buriganga	4/5/04 11:50	29	0.2
	4/5/04 12:45	29.3	0.15
	4/5/04 15:00	29.6	0.12
	4/5/04 16:10	29.5	0.25
Buri-5	12/26/94 7:40	21.1	0.9
Keraniganj	12/26/94 8:45	21	1.1
Buriganga	12/26/94 10:00	21.1	1.5
	12/26/94 11:10	21.1	1.7
	12/26/94 12:12	21.2	1.9
	12/26/94 13:05	21.3	1.3
	12/26/94 14:15	21.4	0.3
	2/16/95 8:30	22	0.8
	2/16/95 10:10	21.8	0.1
	2/16/95 11:35	21.8	0.2
	2/16/95 12:55	22.1	0.3
	2/16/95 14:10	22.2	0.5
	2/16/95 15:45	23.2	0.6
	4/20/95 7:45	29.9	0.6
	4/20/95 9:15	30	1.3
	4/20/95 10:35	30.2	2.7
	4/20/95 11:40	30.3	2.6
	4/20/95 12:50	30.5	3.3
	4/20/95 14:00	30.3	2.2
	4/20/95 15:15	30.3	2.1
	4/20/95 16:25	30.2	2.2
	12/18/97 8:33	21.4	0.9
	12/18/97 9:45	21.4	0.8
	12/18/97 10:57	21.7	0.5
	12/18/97 12:17	21.8	0.3
	12/18/97 13:27	21.9	0.4

Station	Date&Time	Temp ^0C	DO (mg/L)
Buri-5	12/18/97 14:55	21.8	0.4
Keraniganj	12/18/97 16:10	21.8	1.1
Buriganga	1/20/98 9:15	18.8	0.3
	1/20/98 10:35	18.9	0.4
	1/20/98 11:52	18.9	0.3
	1/20/98 12:58	18.9	0.4
	1/20/98 14:18	18.9	0.2
	1/20/98 15:23	18.8	0.2
	2/18/98 9:18	22.5	0.5
	2/18/98 10:45	22.5	0.4
	2/18/98 12:17	22.6	0.3
	2/18/98 13:23	22.5	0.1
	2/18/98 14:38	22.6	0.2
	2/18/98 15:51	22.7	0.3
	2/18/98 16:27	22.7	0.6
	4/26/03 10:15	31.1	0.8
	3/16/04 10:30	25.9	0.07
	3/16/04 11:50	26.6	0.08
	3/16/04 12:45	26.7	0.09
	3/16/04 13:30	27	0.11
	3/16/04 14:25	27.1	0.08
	3/16/04 15:30	27.1	0.06
	4/5/04 10:38	28.7	1.4
	4/5/04 11:25	28.9	1.8
	4/5/04 12:15	28.8	0.82
	4/5/04 13:10	29.1	1.3
	4/5/04 14:30	29.5	1.5
	4/5/04 15:45	29.3	0.52
	4/5/04 16:42	29.3	0.39

Table A.1 continued

Station	Date&Time	Temp ^{0}C	DO (mg/L)	Station	Date&Time	Temp ^{0}C	DO (mg/L)	Station	Date&Time	Temp ^{0}C	DO (mg/L)
Buri-6	12/21/94 8:10	21.3	0.3		1/21/98 15:17	18.3	0.2		4/22/95 10:15	29.9	2.4
Pagla	12/21/94 9:45	21.3	0.9	Buri-6	2/20/98 9:52	22.7	0.3		4/22/95 11:30	30.2	3.4
Buriganga	12/21/94 10:50	21.3	1.4	Pagla	2/20/98 10:55	23	1.6	Buri-7	4/22/95 12:35	30	2.7
	12/21/94 12:25	21.5	1.5	Buriganga	2/20/98 12:53	23.1	1.9	Fatulla	4/22/95 13:44	30.3	3.3
	12/21/94 13:30	21.7	1.7		2/20/98 14:06	23.3	2.1	Buriganga	4/22/95 14:50	30.3	4.5
	12/21/94 14:40	21.8	2.5		2/20/98 15:08	23.2	2.2		4/22/95 15:45	30.3	4.2
	12/21/94 15:50	21.6	0.8		2/20/98 16:13	23.3	2		12/19/97 9:04	21.6	0.4
	12/21/94 17:00	21.5	0.5		4/26/03 11:30	30.3	2		12/19/97 10:40	21.7	0.7
	2/19/95 8:30	22.1	2.4		3/17/04 11:00	26.2	1.65		12/19/97 11:45	21.8	1
	2/19/95 10:10	22.2	6.2		3/17/04 12:30	26.4	1.62		12/19/97 13:15	21.8	2
	2/19/95 11:13	22.3	9.4		3/17/04 13:35	26.1	1		12/19/97 14:33	22	2.3
	2/19/95 12:21	22.5	12.7		3/17/04 15:20	26.5	1.1		12/19/97 15:24	21.8	1.4
	2/19/95 13:29	22.4	11.8		4/6/04 10:40	28.4	5.1		12/19/97 15:48	21.8	1.2
	2/19/95 15:05	22.6	8.8		4/6/04 11:23	28.5	5		1/21/98 11:15	18.3	0.4
	4/22/95 8:10	29.8	1.7		4/6/04 12:03	28.6	5.2		1/21/98 12:25	18.3	0.2
	4/22/95 9:35	29.9	2.6		4/6/04 12:50	28.7	5.2		1/21/98 13:26	18.3	0.5
	4/22/95 11:15	30.1	3		4/6/04 13:30	28.7	4.8		1/21/98 14:34	18.4	0.4
	4/22/95 12:15	30.3	4.3		4/6/04 14:20	28.9	5.02		1/21/98 14:55	18.4	0.4
	4/22/95 13:20	30.3	3.5	Buri-7	12/21/94 8:40	21.3	1		2/20/98 9:25	22.7	0.7
	4/22/95 14:30	30.2	3.8	Fatulla	12/21/94 10:05	21.4	2.7		2/20/98 10:08	23.2	1.9
	4/22/95 15:25	30.2	3	Buriganga	12/21/94 11:10	21.4	3.8		2/20/98 12:13	23	1.2
	4/22/95 16:30	30.2	3.5		12/21/94 12:40	21.7	4.3		2/20/98 13:19	23	1.3
	12/19/97 8:38	21.6	0.3		12/21/94 13:45	21.6	2.6		2/20/98 14:25	23.3	3
	12/19/97 10:00	21.6	0.4		12/21/94 15:00	21.6	2		2/20/98 15:28	23.3	3.3
	12/19/97 11:20	21.7	0.7		12/21/94 16:10	21.5	1.7		4/26/03 12:15	30.5	1.8
	12/19/97 12:47	21.8	0.4		12/21/94 16:45	21.5	1.5		3/17/04 11:45	26.1	1
	12/19/97 14:05	21.8	0.8		2/19/95 9:00	22.2	9.9		3/17/04 13:30	26.8	2.3
	12/19/97 15:08	21.8	0.4		2/19/95 10:30	22.3	14.5		3/17/04 14:05	26.7	2.35
	12/19/97 16:10	21.8	0.5		2/19/95 11:36	22.3	15.5		3/17/04 14:45	26.6	2.4
	1/21/98 10:50	18.3	0.2		2/19/95 12:40	22.6	17.2		3/17/04 16:00	26.5	2.5
	1/21/98 12:07	18.3	0.4		2/19/95 14:23	22.6	16.2		4/6/04 10:20	28.3	5.4
	1/21/98 13:05	18.3	0.4		2/19/95 15:25	22.6	13.6		4/6/04 11:03	28.4	5.57
	1/21/98 14:14	18.3	0.2		4/22/95 8:40	29.8	2.3		4/6/04 11:44	28.4	5.3

Table A.1 continued

Station	Date&Time	Temp ^0C	DO (mg/L)
Buri-7	4/6/04 12:27	28.5	5.5
Fatulla	4/6/04 13:10	28.7	5.65
Buriganga	4/6/04 13:55	28.7	5.5
Buri-9	12/22/94 8:40	21.3	3.5
Nabinagar	12/22/94 11:15	21.3	4.9
Dhaleswari	12/22/94 12:05	21.3	4.9
	12/22/94 13:10	21.3	5
	12/22/94 14:15	21.3	5.1
	12/22/94 15:35	21.3	5
	12/22/94 16:20	21.3	4.9
	2/20/95 9:15	22.4	15.1
	2/20/95 10:30	22.4	16.8
	2/20/95 12:22	22.5	16.8
	2/20/95 13:20	22.8	19.2
	2/20/95 14:20	23.8	22.7
	2/20/95 15:30	22.8	17.8
	2/20/95 16:25	22.8	18.8
	4/23/95 8:25	30	4.5
	4/23/95 9:40	30.2	4.8
	4/23/95 11:15	30.4	4.8
	4/23/95 12:30	30.6	5.3
	4/23/95 13:25	31	7.1
	4/23/95 14:30	31.2	5.9
	4/23/95 15:25	30.9	5.7
	12/21/97 9:02	21.3	1.1
	12/21/97 10:10	21.3	2.4
	12/21/97 11:46	21.4	3
	12/21/97 12:41	21.5	3.4
	12/21/97 14:05	21.4	5.8
	12/21/97 15:04	21.5	5.4
	12/21/97 16:01	21.3	6.4
	1/22/98 10:20	18.6	6

Station	Date&Time	Temp ^0C	DO (mg/L)
	1/22/98 11:25	18.6	4.8
	1/22/98 12:33	18.8	6.8
Buri-9	1/22/98 13:20	18.9	7.4
Nabinagar	1/22/98 14:12	18.8	8.1
Dhaleswari	1/22/98 15:06	18.8	7.8
	2/21/98 9:15	23.2	6.3
	2/21/98 10:10	23.3	7
	2/21/98 10:58	23.4	7
	2/21/98 11:47	23.5	8
	2/21/98 12:43	23.5	8.2
	2/21/98 13:45	23.7	8.5
	2/21/98 14:57	23.8	10.2
	2/21/98 15:52	23.7	9.4
	4/27/03 12:00	30.4	3.5
	3/18/04 9:25	25.9	4
	3/18/04 11:00	26	3.6
	3/18/04 11:55	26.1	3.3
	3/18/04 12:55	26.1	2.8
	3/18/04 14:00	26.2	2.7
	4/10/04 11:46	27.8	5.2
	4/10/04 12:42	27.8	5.4
	4/10/04 13:41	27.7	5.45
	4/10/04 14:43	27.8	5.36
	4/10/04 15:50	27.7	5.4
Buri-10	12/22/94 9:30	21.1	5
Kashipur	12/22/94 10:55	21.2	5
Dhaleswari	12/22/94 11:40	21.3	4.9
	12/22/94 12:40	21.3	4.7
	12/22/94 13:45	21.2	5
	12/22/94 14:45	21.3	5.1
	12/22/94 16:00	21.3	4.9
	12/22/94 16:45	21.4	5.1

Station	Date&Time	Temp ^0C	DO (mg/L)
	2/20/95 10:00	22.3	15.9
Buri-10	2/20/95 11:40	22.6	12.1
Kashipur	2/20/95 12:51	23.3	11.9
Dhaleswari	2/20/95 13:50	23.1	11.9
	2/20/95 14:53	22.9	13.5
	2/20/95 15:58	23	18
	4/23/95 9:30	29.9	6.2
	4/23/95 10:52	30.2	5.8
	4/23/95 11:45	30.4	5.8
	4/23/95 13:00	30.6	5.9
	4/23/95 14:00	30.5	5.8
	4/23/95 14:55	30.7	6.3
	4/23/95 16:05	30.6	6.3
	12/21/97 9:38	21.2	4.4
	12/21/97 11:17	21.3	5.2
	12/21/97 12:15	21.3	5.5
	12/21/97 13:25	21.3	6
	12/21/97 14:31	21.3	6.1
	12/21/97 15:30	21.3	6.7
	1/22/98 10:55	18.6	9.1
	1/22/98 12:05	18.8	8
	1/22/98 12:54	18.8	8
	1/22/98 13:46	18.9	8.8
	1/22/98 14:38	18.8	8.9
	2/21/98 9:40	23	10.3
	2/21/98 11:18	23.3	9.8
	2/21/98 12:16	23.3	9.3
	2/21/98 13:12	23.4	10.1
	2/21/98 14:17	23.8	12
	2/21/98 15:20	23.4	12.1
	4/27/03 12:35	30.6	5.1
	3/18/04 10:20	26.5	5.5

Table A.1 continued

Station	Date&Time	Temp ^{0}C	DO (mg/L)
Buri-10 Kashipur Dhaleswari	3/18/04 11:30	26.6	6.1
	3/18/04 12:25	27	6.6
	3/18/04 13:25	27	6.5
	3/18/04 15:25	27.1	6.4
	4/10/04 12:15	27.6	5.4
	4/10/04 13:11	27.7	6.4
	4/10/04 14:14	28	6.9
	4/10/04 15:20	27.7	6.5
	4/10/04 16:20	27.9	6.1
Buri-11 Kalagachia Dhaleswari	12/23/94 8:35	22.3	2.8
	12/23/94 10:40	21.8	8
	12/23/94 11:45	21.8	6.8
	12/23/94 12:37	21.9	6.9
	12/23/94 13:40	22.2	7.1
	12/23/94 14:35	22.5	7.5
	12/23/94 15:25	22.2	7.3
	12/23/94 16:20	22	7.6
	2/21/95 9:20	22.2	9
	2/21/95 10:18	22.4	9.5
	2/21/95 12:00	22.6	10.5
	2/21/95 12:53	22.8	10.6
	2/21/95 13:40	22.8	10.2
	2/21/95 14:25	23.2	10
	2/21/95 15:12	23	10.8
	4/24/95 8:45	29.9	7.1
	4/24/95 10:25	30	7.6
	4/24/95 11:15	30.2	7.7
	4/24/95 12:05	30.3	7.3
	4/24/95 13:00	30.5	6.4
	4/24/95 14:35	30.8	6.7
	4/24/95 15:35	30.5	7.8
	4/24/95 16:30	31.3	8.2

Station	Date&Time	Temp ^{0}C	DO (mg/L)
Buri-11 Kalagachia Dhaleswari	12/22/97 9:46	21.8	4.3
	12/22/97 12:00	22	3.5
	12/22/97 12:53	22	5
	12/22/97 13:52	21.8	5.4
	12/22/97 14:50	21.5	8.8
	1/23/98 10:05	18.8	8.2
	1/23/98 11:33	19.3	4.8
	1/23/98 12:22	19.4	3.8
	1/23/98 13:25	18.9	4
	1/23/98 14:27	19.1	4.2
	2/22/98 10:05	22.9	8.8
	2/22/98 12:26	23.6	5.5
	2/22/98 14:15	24	4.2
	2/22/98 15:05	23.9	3.9
	2/22/98 15:54	23.8	8.2
	4/27/03 13:30	30.8	5.3
	3/20/04 10:00	26.4	7.3
	3/20/04 10:50	26.5	7.5
	3/20/04 11:35	26.6	7.6
	3/20/04 12:45	27	7.9
	4/11/04 10:50	27.7	6.23
	4/11/04 11:37	27.8	6.1
	4/11/04 12:30	27.8	6.2
	4/11/04 13:18	27.8	6.65
	4/11/04 14:08	27.9	6.7
	4/11/04 15:10	27.9	6.5
	4/11/04 16:05	27.9	6.63
Lakh-1 Mosinabanda Lakhaya river	12/23/94 9:05	22.3	3
	12/23/94 10:05	22.4	2.8
	12/23/94 11:10	22.4	2.7
	12/23/94 12:10	22.4	2.8
	12/23/94 13:15	22	5.4

Station	Date&Time	Temp ^{0}C	DO (mg/L)
Lakh-1 Mosinabanda Lakhaya river	12/23/94 14:10	22.2	5.4
	12/23/94 15:00	22.7	3.7
	12/23/94 16:00	22.5	3.2
	12/23/94 16:45	22.5	3
	2/21/95 8:50	22.4	9.2
	2/21/95 9:52	22.5	9.4
	2/21/95 10:41	22.5	10.1
	2/21/95 12:25	22.7	10.2
	2/21/95 13:15	22.8	10.4
	2/21/95 14:03	22.8	10.5
	2/21/95 14:50	23.1	10.3
	2/21/95 15:40	23	10.3
	4/24/95 8:15	30.1	6.1
	4/24/95 9:16	30.2	5.8
	4/24/95 10:50	30.4	5.4
	4/24/95 11:43	30.6	5.3
	4/24/95 12:35	30.6	5.5
	4/24/95 13:25	30.7	6.1
	4/24/95 15:00	30.9	6.6
	4/24/95 15:55	31	6.9
	4/24/95 17:00	30.7	5.6
	12/22/97 10:18	22	1.8
	12/22/97 11:38	22.1	3.2
	12/22/97 12:25	22	3.2
	12/22/97 13:25	22.3	2.5
	12/22/97 14:20	22.2	4
	12/22/97 15:40	22.1	3
	1/23/98 9:40	19.4	3.6
	1/23/98 11:12	19.5	3.3
	1/23/98 12:00	19.5	3.2
	1/23/98 12:50	19.7	3.3
	1/23/98 13:58	19.8	3.2

Table A.1 continued

Station	Date&Time	Temp ^{0}C	DO (mg/L)	Station	Date&Time	Temp ^{0}C	DO (mg/L)	Station	Date&Time	Temp ^{0}C	DO (mg/L)
Lakh-1	1/23/98 15:01	19.8	3	Lakh-2	12/24/94 7:30	21.8	3.8	Lakh-2	1/24/98 11:45	20.1	1.5
Mosinabanda	2/22/98 9:30	23.5	2.9	Siddhirganj	12/24/94 8:30	22	4.1	Siddhirganj	1/24/98 12:40	20.2	1.8
Lakhaya river	2/22/98 10:40	23.6	1.8	Lakhaya river	12/24/94 9:35	22	4.2	Lakhaya river	1/24/98 13:35	20.2	2
	2/22/98 11:52	23.7	1.5		12/24/94 10:30	22.1	4		1/24/98 14:30	20.2	1.5
	2/22/98 12:48	23.9	1.3		12/24/94 11:45	22.4	3.5		2/23/98 10:45	24.2	0.7
	2/22/98 13:52	24.1	1.3		12/24/94 12:45	22.4	3.2		2/23/98 12:07	24.2	0.5
	2/22/98 14:40	24	1.3		12/24/94 13:40	22.5	3.5		2/23/98 13:04	24.3	0.5
	2/22/98 15:28	24.2	1.7		12/24/94 14:50	22.6	3.5		2/23/98 14:12	24.5	0.5
	2/22/98 16:17	24.1	2.1		12/24/94 16:00	22.7	3.5		2/23/98 15:08	24.6	0.4
	4/27/03 14:00	30.4	2.2		2/22/95 8:40	23.2	2.3		2/23/98 16:07	24.7	0.6
	3/20/04 10:25	26.5	7.1		2/22/95 10:00	23.4	2.5		4/30/03 13:20	31.9	3.2
	3/20/04 11:10	27	7.2		2/22/95 10:55	23.6	2.8		3/21/04 11:00	27.3	5.1
	3/20/04 12:00	26.9	7.2		2/22/95 11:52	23.6	2.7		3/21/04 12:20	27.6	4.6
	3/20/04 13:30	27	7.3		2/22/95 12:55	24.2	2.8		3/21/04 13:40	27.6	5.3
	4/11/04 11:10	27.9	4.41		2/22/95 13:44	23.8	3.2		3/21/04 15:20	27.8	5
	4/11/04 12:00	27.9	4.74		2/22/95 14:44	23.9	4		4/12/04 11:15	28.5	0.45
	4/11/04 12:50	27.9	4.9		4/25/95 8:25	31.1	4.7		4/12/04 12:25	28.5	0.66
	4/11/04 13:40	28	5.4		4/25/95 9:45	31	4.8		4/12/04 13:30	29.4	1.00
	4/11/04 14:35	28	5.8		4/25/95 10:40	31.2	4.6		4/12/04 14:40	29.7	1.40
	4/11/04 15:40	28.5	5.82		4/25/95 11:30	31.4	5		4/12/04 16:40	29.6	1.60
	4/11/04 16:35	28.8	5.22		4/25/95 12:20	31.4	4.2	Lakh-2a	3/24/04 9:35	28.4	1.46
Lakh-1a	3/21/04 10:20	26.8	6.3		4/25/95 13:45	31.3	3.4	Sarulia	3/24/04 9:45	28.4	1.5
Pathantali	3/21/04 11:40	26.9	6.5		4/25/95 14:42	31.2	3	Lakhaya river	3/24/04 10:05	28.4	1.8
Lakhaya river	3/21/04 13:00	27.1	6.7		4/25/95 15:30	31.5	2.9		3/24/04 10:20	28.5	2.1
	3/21/04 14:20	27.3	6		12/23/97 9:08	21.8	2.6		3/24/04 10:35	28.5	2.4
	4/12/04 10:45	29.1	1.89		12/23/97 10:21	21.8	4.1		3/24/04 10:55	28.4	3.8
	4/12/04 11:45	29.1	1.72		12/23/97 11:17	21.8	2.8		3/24/04 11:15	28.5	3.7
	4/12/04 13:00	29.2	2.6		12/23/97 12:15	21.1	3.1		3/24/04 11:35	28.5	4.5
	4/12/04 14:00	29.3	3.2		12/23/97 13:10	22.1	3.4		3/24/04 11:55	28.5	4.55
	4/12/04 15:30	29.4	3.4		12/23/97 14:33	22.1	3.6		3/24/04 12:15	28.6	4.8
					12/23/97 15:28	22	3		3/24/04 12:50	28.7	4.9
					1/24/98 9:20	19.8	1.1		3/24/04 13:20	28.6	4.5
					1/24/98 10:50	19.8	1		3/24/04 13:35	28.6	4.2

Table A.1 continued

Station	Date&Time	Temp ^{0}C	DO (mg/L)
Lakh-2a	4/15/04 9:25	29.2	1.25
Sarulia	4/15/04 9:40	29.2	1.1
Lakhaya river	4/15/04 10:05	29.2	1.2
	4/15/04 10:35	29.1	1.21
	4/15/04 10:50	29.2	1.1
	4/15/04 11:15	29.1	1
	4/15/04 11:40	29.1	1.15
	4/15/04 12:20	29.1	1.4
	4/15/04 12:45	29.1	1.2
Lakh-3	12/24/94 7:00	22	6.6
Demra	12/24/94 8:00	22	7.1
Lakhaya river	12/24/94 9:05	22	7.3
	12/24/94 10:00	21.9	6.4
	12/24/94 10:55	22	5.6
	12/24/94 12:10	22.1	5.2
	12/24/94 13:10	22.2	4.6
	12/24/94 14:10	22.4	4.2
	12/24/94 15:30	22.3	4.2
	12/24/94 16:25	22.4	4.5
	2/22/95 8:00	23.2	3.4
	2/22/95 9:25	23.1	5.2
	2/22/95 10:30	23.2	6
	2/22/95 11:25	23.3	5.1
	2/22/95 12:15	23.5	4.6
	2/22/95 13:16	23.5	4
	2/22/95 14:12	23.7	3.5
	2/22/95 15:10	23.8	3
	4/25/95 7:50	30.9	2.2
	4/25/95 8:53	31	2.2
	4/25/95 10:12	31	2
	4/25/95 11:00	31.1	2.2
	4/25/95 11:52	31.1	1.9
	4/25/95 12:55	31.3	2.6
	4/25/95 14:10	31.3	2.6

Station	Date&Time	Temp ^{0}C	DO (mg/L)
Lakh-3	4/25/95 15:05	31.2	3.9
Demra	4/25/95 15:55	31.5	4
Lakhaya river	12/23/97 8:39	21.8	4.7
	12/23/97 9:46	22.1	5.5
	12/23/97 10:48	22.2	8.1
	12/23/97 11:46	22.2	6.5
	12/23/97 12:47	22.3	6.1
	12/23/97 13:45	22.2	5.8
	12/23/97 15:00	22.2	5.7
	12/23/97 16:20	22.1	5.6
	1/24/98 8:50	20	3
	1/24/98 9:55	20.1	3.2
	1/24/98 11:20	20.3	4.8
	1/24/98 12:15	20.3	5.6
	1/24/98 13:10	20.5	7.2
	1/24/98 14:03	20.7	8.7
	1/24/98 14:55	20.7	5.7
	2/23/98 10:10	24.3	1.1
	2/23/98 11:20	24.3	1.3
	2/23/98 12:35	24.5	1.5
	2/23/98 13:33	24.7	1.6
	2/23/98 14:40	24.8	1.6
	2/23/98 15:37	24.9	1
	2/23/98 16:33	24.7	1.7
	3/24/04 9:25	28.3	1.65
	3/24/04 9:40	28.4	1.47
	3/24/04 9:53	28.4	1.31
	3/24/04 10:10	28.4	1.7
	3/24/04 10:30	28.5	1.7
	3/24/04 10:45	28.4	2.3
	3/24/04 11:05	28.5	3.1
	3/24/04 11:25	28.6	3.2
	3/24/04 11:45	28.5	3.9
	3/24/04 12:05	28.6	3.7

Station	Date&Time	Temp ^{0}C	DO (mg/L)
Lakh-3	3/24/04 12:30	28.6	4.5
Demra	3/24/04 13:09	28.6	4.4
Lakhaya river	3/24/04 13:27	28.6	4.85
	3/24/04 13:40	28.6	4.72
	4/15/04 9:15	28.6	0.60
	4/15/04 9:35	28.6	0.63
	4/15/04 9:55	28.9	0.73
	4/15/04 10:20	29.1	0.67
	4/15/04 10:45	29.1	0.77
	4/15/04 11:10	28.9	1.10
	4/15/04 11:30	28.8	0.84
	4/15/04 12:05	29.3	1.90
	4/15/04 12:35	29.4	2.10
	4/15/04 13:10	29.3	2.00
Lakh-4	12/24/97 8:55	21.7	6.2
Gandharbapur	12/24/97 9:56	21.8	6.9
Lakhaya river	12/24/97 10:57	22	7
	12/24/97 11:58	22.1	6.5
	12/24/97 13:00	22.1	6.8
	12/24/97 14:04	22.2	6.8
	12/24/97 15:03	22.3	6.8
	12/24/97 16:04	22.3	6.6
	1/25/98 9:15	20.4	8.5
	1/25/98 10:19	20.5	5.2
	1/25/98 11:10	20.8	5.7
	1/25/98 12:10	20.9	5.7
	1/25/98 13:08	20.8	6.5
	1/25/98 14:01	21.2	6.8
	1/25/98 14:42	21.1	7.2
	2/24/98 9:30	24.3	1
	2/24/98 10:40	24.5	0.9
	2/24/98 11:42	24.6	3.2
	2/24/98 12:39	24.8	2.8
	2/24/98 13:38	24.7	3.5

Table A.1 continued

Station	Date&Time	Temp ^{0}C	DO (mg/L)	Station	Date&Time	Temp ^{0}C	DO (mg/L)	Station	Date&Time	Temp ^{0}C	DO (mg/L)
Lakh-4	2/24/98 14:40	24.8	3.8	Lakh-5	4/13/04 11:35	28.4	2.16	Balu-1	4/14/04 10:45	28.6	0.5
Gandharbapur	2/24/98 15:37	24.8	5.7	Rupganj	4/13/04 12:40	28.3	3.05	Keodala	4/14/04 11:40	28.6	0.55
Lakhaya river	2/24/98 16:34	24.8	6.3	Lakhaya river	4/13/04 13:40	28.6	3.48	Balu river	4/14/04 14:00	29.1	0.1
	4/28/03 14:45	31.7	5.8	Balu-1	12/25/97 8:14	19.2	0.2		4/14/04 15:20	29.1	0.12
	3/22/04 10:10	28.5	0.98	Keodala	12/25/97 9:10	19.2	0.1	Balu-2	12/25/97 8:43	19.3	0.1
	3/22/04 11:20	28.5	0.7	Balu river	12/25/97 10:20	19.3	0.1	Balurpar	12/25/97 11:05	19.5	0.2
	3/22/04 12:50	28.7	2.7		12/25/97 11:25	19.4	0.1	Balu river	12/25/97 11:51	19.6	0.3
	3/22/04 15:20	28.9	1.98		12/25/97 12:20	19.6	0.1		12/25/97 12:50	19.7	1.4
	4/13/04 11:00	28.3	2.05		12/25/97 13:15	19.6	0.2		12/25/97 13:50	19.6	3.3
	4/13/04 12:00	28.4	2.25		12/25/97 14:13	19.8	0.2		12/25/97 14:38	19.7	4
	4/13/04 13:10	28.4	2.36		12/25/97 15:00	19.9	0.2		12/25/97 15:25	19.7	4.2
	4/13/04 15:00	28.6	2.62		12/25/97 15:50	19.9	0.2		1/26/98 9:55	19.9	0.2
Lakh-5	12/24/97 9:27	22.1	6.3		1/26/98 9:30	20.5	6.3		1/26/98 11:35	20.2	0.3
Rupganj	12/24/97 11:34	22.4	6.6		1/26/98 10:23	20.6	6.6		1/26/98 12:27	20.3	0.4
Lakhaya river	12/24/97 12:34	22.6	7.6		1/26/98 11:12	20.8	6.5		1/26/98 13:28	20.6	0.2
	12/24/97 13:37	22.6	7.5		1/26/98 12:04	20.6	4.3		1/26/98 14:22	20.5	0.2
	12/24/97 14:35	22.4	7.4		1/26/98 12:52	20.3	0.4		2/25/98 9:35	25	0.1
	12/24/97 15:35	22.3	7.3		1/26/98 13:58	20	0.3		2/25/98 11:35	25.6	0.1
	1/25/98 9:50	20.8	7.4		1/26/98 14:44	20.1	0.2		2/25/98 12:38	25.7	0.1
	1/25/98 11:43	21.2	7.9		2/25/98 9:05	24.7	1.3		2/25/98 13:35	25.6	0.1
	1/25/98 12:39	21.3	8.2		2/25/98 10:10	24.7	1		2/25/98 14:42	25.7	0.1
	1/25/98 13:35	21.3	8.3		2/25/98 11:05	24.8	1.1		2/25/98 15:40	25.8	0.1
	1/25/98 14:23	21.2	8.5		2/25/98 12:06	25.2	1.6		4/28/03 15:00	32.32	0.1
	2/24/98 10:05	24.3	6		2/25/98 13:04	25.2	1.3		3/23/04 10:25	28.5	0.35
	2/24/98 12:10	24.9	6.8		2/25/98 14:14	25.2	0.3		3/23/04 11:25	28.5	0.5
	2/24/98 13:08	24.8	7.9		2/25/98 15:12	25.3	0.1		3/23/04 12:25	28.6	1.6
	2/24/98 14:10	24.8	7.8		2/25/98 16:05	25.4	0.1		3/23/04 13:40	28.8	2.3
	2/24/98 15:09	24.9	7.6		4/28/03 13:45	31.9	4		3/23/04 15:50	29.2	4.1
	2/24/98 16:06	24.7	7.4		3/23/04 10:00	28.3	1.5		4/14/04 10:20	28.7	0.15
	4/28/03 12:00	31.6	7.7		3/23/04 11:00	28.4	1.55		4/14/04 11:15	28.8	0.12
	3/22/04 10:40	28.3	0.8		3/23/04 12:00	28.6	1.6		4/14/04 12:10	28.9	0.1
	3/22/04 12:00	28.6	1.7		3/23/04 13:00	28.8	2.6		4/14/04 13:25	29.2	0.08
	3/22/04 13:30	28.7	2.6		3/23/04 16:20	29.1	3.6		4/14/04 14:40	29.1	0.07
	3/22/04 14:00	28.7	2		4/14/04 9:55	28.6	0.8				

Table A.2 Water Quality Data at Hazaribag on the Turag River (Source: Kamal, 1996)

Date	pH		Chloride		T. Alkalinity		TSS		DO		BOD		COD		NH3		Coli-colonies		Chromium	
9-Jan-80	7.7	7.8	8	9	172	180	11	15	6.8	11.9	1.7	7.4			0	0	700	1400		
10-May-80	7.5	7.8	12	14.5	112	120	6	30	5.8	6.2	2.1	3.1			0	0	1000	8000		
14-Jun-80	6.5	6.8	9.5	18	44	48	8	10	3	4.1	1.7	3	0	0	0.1	0.4	1000	1300		
10-JuJ-80	7.1	7.3	2	2.5	56	60	19	38	5.2	6.2	3	4	0	0	0	0	2000	3800		
6-Aug-80	7.4	7.7	2.5	3	56	68	5	45	5.9	6.2	3.6	4.4	0	0	0	0	4000	9500		
5-Jan-83	6.9	7.15	10.5	10.5	182	183	23	28	6.75	6.9	1.1	1.55					19.5	102.5		
3-Feb-83	7.1	7.1	27.5	265	172	173	81	81	5.05	6	2.9	5.35					68	72		
9-Mar-83	6.9	7.05	84	86	174	176	102	103	3.45	3.7	3.5	4								
12-Apr-83	6.65	6.75	125	135	177	183	102	105.5	5.9	6.1	5.45	5.55								
12-May-83	7.1	7.15	190	220	154	156	163	171.5	3.9	4.2	?5	3.51								
22-Jun-83	6.3	6.55	445	450	83	185	96	107.5	2.2	2.6	3.5	4								
21-Jul-83	6.2	6.2	3.5	3.5	52	54	30	30.5	6.4	6.7	0.95	2.2								
17-Aug-83	6.55	6.65	15	15.5	53	57	33	44	6.75	7.1	0.45	1.62								
11-Sep-83	7.05	7.05	5	6	56	61	34	34.5	8.4	8.7	1.4	1.5								
5-Oct-83	6.9	6.9	7	7.5	57	57	26.5	27	1.4	1.45	21.5	24.5								
10-Nov-83	7	7.1	14	17	56	62	30.5	34	7.3	7.4	1.2	1.3								
7-Dec-83	7.35	7.45	27.5	30.5	103	116	49.5	51.5	6.8	6.85	1.9	1.95								
4-Jan-84	7	7.2	70	72	122	160	73	80	4.3	5.1	2.2	2.8								
09-Feh-84	7.1	7.3	53	56	154	166	74	77	7.4	7.5	5.8	6.6								
13-Mar-84	7	7.?	83	211	150	158	94	104	6.9	8.1	1.1	1.9								
7-Apr-84	7.4	7.5	38	45	140	154	61	64	6	7.3	1.3	1.8								
19-May-84	7.2	7.6	15	19	44	50	35	40	7.2	8.5	3.5	6.2								
5-Jun-84	7	7.2	15	17	42	48	43	53	4.3	4.7	3.7	4.1								
07-JuJ-84	7.1	7.4	8	24	34	44	43	55	6.2	7.2	1.4	2.2								
5-Aug-84	7.1	7.2	6	11	32	46	30	32	3.4	4.1	1.3	1.6								

Table A.2 continued

Date	pH		Chloride		T. Alkalinity		TSS		DO		BOD		COD		NH3		Coli-colonies		Chromium	
12-Sep-84	7	7.1	14	18	44	48	31	52	4	4.8	0.4	1.8								
7-Oct-84	7	7.3	6	8	40	194	13	33	7	7.4	4.1	4.5	5.5	11			1400	1800	0.01	0.63
8-Nov-84	7.2	7.4	7	8	64	70	36	45	5.9	10.9	0.5	2.3	7	10					0.31	0.62
9-Dec-84	7.2	7.4	15	29	120	144	66	80	6.2	6.6	5.1	6.1	22	29						
3-Jan-85	7.5	8.4	40	3350	128	760	92	1108	6.3	7	1.1	2.9	6	13					0.04	0.13
6-Feb-85	7.1	7.4	31	35	148	156	81	86	5.1	5.3	2	2.3	18	25	0.04	0.16				
4-Mar-85	6.6	6.8	45	52	136	142	111	124	3.3	3.9	2.1	2.7	7	II						
4-Apr-85	6.1	7.1	50	55	136	148	74	86	7.2	7.7	3	3.4	12	16						
8-May-85	6.1	6.8	51	63	130	240	60	70	4.5	5.7	1.3	2.8	11	14						
3-Jun-85	6.7	7.5	43	54	144	260	66	72	6.2	6.5	1.6	1.9	11	18						
14-Aug-85	6.9	7.1	13	15	42	46	121	152	5.1	6	2.3	3								
13-Oct-87	6.9	7.1	11.5	13.5	84	92	40	49	6.4	6.8	2.2	2.4	46	46						
8-Feb-88	6.8	7.1	17	60	63	70	122	127	5.8	6.4			49.2	198						
9-May-88	7.3	7.9	56	56.5	110	114	96	176	4.3	5.3	2.1	2.6								
6-Jun-88	6.8	6.9	4	9	36	46	46	61	3.7	4.6	0.8	3.6								
7-Aug-88	6.9	7.1	4.5	5	26	54	15	20	6.6	8.1	0.3	2.2								
15-Oct-88	7	7.1	6	9	60	64	20	22	7	7.1	I	1.4								
27-Nov-88	7.1	7.2	8	9	64	72	47	50	5	6.5	1.7	1.8								
12-Dec-88	7.1	7.2	8	10	64	72	38	40	6.3	6.6	1.5	2.1								
21-Jan-89	7.2	7.4	6	9	60	68	36	47	6.2	7.5	1.7	1.9								
20-Feb-89	7.3	7.4	8	14	64	76	93	101	5.8	6	1.2	1.5								
10-Apr-89	7.4	7.4	10	18	68	80	45	48	5.3	5.6	1.4	1.7								
27-Jun-89	7.1	7.3	12	22	92	104	40	47	5.7	5.9	1.7	2.2								
25-Jul-89	7.1	7.2	34	37	56	72	25	27	6.1	6.5	1.8	2.1								
9-Sep-89	7.3	7.4	46	50	64	76	31	33	6.6	6.9	1.9	2.2								
11-Nov-89	7.3	7.5	48	52	72	88	29	30	6.2	6.4	1.8	2.5								

Table A.2 continued

Date	pH		Chloride		T. Alkalinity		TSS		DO		BOD		COD		NH3		Coli-colonies		Chromium	
17-Feb-90	7.5	7.6	59	63	140	152	40	44	6.3	6.5	2	2.3								
8-Mar-90	7.4	7.5	62	65	140	156	44	48	6.2	6.3	2	2.3								
10-Apr-90	7.7	7.8	67	70	152	168	51	53	6.2	6.5	2	2.1								
10-May-90	7.4	7.5	63	68	164	176	50	55	6.1	6.4	1.8	2.1								
3-Jun-90	7.2	7.4	60	64	156	164	48	50	6	6.3	2	2.3								
15-Jul-90	7	7	40	43	60	72	60	63	6.3	6.6	2.3	2.8								
11-Aug-90	7	7.2	27	30	84	88	70	73	6.3	6.6	2	2.3								
9-Sep-90	7.2	7.4	28	32	84	100	49	53	6.2	6.5	1.7	2								
14-Oct-90	7.3	7.4	32	35	96	112	50	53	6	6.3	1.1	1.9								
20-Dec-90	7.2	7.4	28	32	88	92	32	34	6.1	6.4										
5-Jan-91	7.3	7.5	32	38	96	100	11	25	6	6.3										
8-May-91	7.2	7.3	100	110	196	204	42	45	2	2.3	190	210								
9-Jun-91	6.7	7.2	70	72	160	168	50	52	5.3	5.6	1.5	2.2								
7-Aug-91	7.3	7.5	65	68	178	210	62	65	5.5	5.8	1.7	2.4								
18-Apr-92	7.3	7.5	34	36	168	184	38	44	6	6.2	2.7	3.2								
8-Jun-92	7.4	7.5	33	36	180	188	37	41	6.1	6.4	2.7	3.1								
5-Jul-92	7.2	7.4	31	34	152	168	50	52	5.8	6	2.7	3.4								
17-Aug-92	7.2	7.3	30	33	148	160	49	52	6.4	6.7	2.7	3.1								
5-Oct-92	7.3	7.6	36	39	184	204	51	57	5.7	6.2	3.4	4								
13-Nov-92	7.6	7.7	38	40	192	196	34	38	5.3	5.7	3.1	3.7							0	0
3-Dec-92	7.6	7.7	36	41	188	204	24	26	6.2	6.5	3	3.8							0	0
27-Apr-93	7.5	7.7	19.5	21	220	232	36	40	5.4	5.8	2.8	3.3								
30-Jun-93	6.7	6.8	22	25	28	32	36	40	6.4	6.7	0.4	2	26	36					0	0
6-Jul-93	6.4	6.5	27.5	30	24	30	52	60	5.8	6.2	1.9	2.1								
24-Aug-93	6.8	7.2	20.5	22	24	30	60	63	6.6	6.8	1.6	2								
6-Oct-93	6.8	6.9	22.5	25	40	46	49	54	5.7	5.9	2.5	3	8	10					0	0

Table A.2 continued

Date	pH		Chloride		T. Alkalinity		TSS		DO		BOD		COD		NH3		Coli-colonies		Chromium	
20-Nov-93	7.1	7.2	27	27.5	42	50	37	40	5.4	5.6	2.2	2.5							0	0
3-Mar-94	7.2	7.4	24	28	112	124	33	36	5.6	5.8	2.6	3.3								
3-Jun-94	7.1	7.3	31	33	124	132	38	42	6.2	6.5	2.2	2.6							0	0
3-Jul-94	6.8	7.1	25	27	64	70	44	49	7	8	2.5	3							0	0
1-Aug-94	7.1	7.3	18	22	72	76	47	52	6.1	6.5	3.4	3.8								
7-Sep-94	7.1	7.2	15.5	18	76	82	40	43	6	6.5	3.1	3.5								
6-Oct-94	7.1	7.2	18	21	78	82	35	38	6.2	6.7	3.2	3.8								
10-Dec-94	7.3	7.5	20	23	74	82	44	46	3.3	3.8	2.9	3.3								

Note: All parameters are in mg/l except pH and Coliform

Coliforms in 1000/ 100 ml of water

Table A.3 Water Quality Data at Chandni Ghat on the Buriganga (Source: Kamal, 1996)

Date	pH		Chloride		T.Alkalinity		TSS		D.O.		BOD		COD		NH_3		Coli-colonies		Chromium	
08-Jan-80	7.7	7.9	13.5	16	172	180	12	16	5.1	5.8	1.3	4	0	0	0	0	1500	12000		
12-Feb-80	7.4	7.6	25	27	172	180	19	23	2.8	4.2	1.1	2.1	0	0	0	0	2200	5200		
14-Mar-80	7.1	7.4	41	42	160	196	31	32	6.2	6.6	3.2	3.7	0	0			5200	6200		
04-Apr-80	6.8	7.1	37.5	38.5	152	180	29	33	1.5	3	1.1	2.2	0	0	0	0	6000	9000		
16-Jun-80	6.3	6.5	6.5	8	24	56	41	45	3.1	4.1	1.6	2	0	0	0	0	1350	13300		
09-Jul-80	7.5	7.6	6	6	32	68	25	61	3.8	4.1	1.6	2	0	0	0	0	4500	6000		
06-Aug-80	7	7.1	2.5	2.5	56	64	7	180	4.4	6.1	1.8	4.1	0	0	0	0	12900	13500		
06-Sep-80	7.1	7.4	2	2	60	68	31	49	6.1	7.1	3.9	4.9	0	0	0	0	5000	6500		
06-Apr-83	6.6	6.75	97	110	127	153	96.5	103.5	2.75	3	21	25								
05-May-83	7.3	7.45	34.5	35	98	99	56	75.5	3.1	3.3	20	23								
20-Jun-83	6.15	6.2	15	15	63	69	42.5	46	4.75	4.8	4.3	4.35								
05-Jul-83	7.2	7.5	21	21.5	52	58	36	44	1.7	1.9	30	31								
03-Aug-83	5.7	5.95	1.5	3.5	53	54	57.5	65.5	6.05	6.15	0.75	0.85								
04-Sep-83	7.25	7.25	3.5	3.5	53	67	21.5	36.5	6.35	6.7	4.85	5.3								
03-Jan-84	7.15	7.2	43	45	152	156	71.5	74	4.55	4.65	1.65	1.9								
07-Feb-84	6.85	7.1	64	64.5	163	169	64.5	65	3.2	3.3	0.09	0.09								
06-Mar-84	7.7	7.85	84	85	160	170	108.5	114	5.85	6.45	1.75	1.9								
03-Apr-84	7.2	7.3	33	34	170	171	56	59	5.75	5.9	3.95	4.15								
07-May-84	7.1	7.15	25.5	26	124	128	62.5	64	3.1	3.3	1.05	1.55								
03-Jun-84	6.85	6.85	24	24	46	48	48	50	2.8	3.35	I	1.5								
05-Jul-84	7,15	7.25	13	14	54	55	46.5	49	4.55	4.75	4.2	4.2								
02-Aug-84	6.95	6.95	14.5	16	82	132	29	30.5	4.8	5	1.2	1.2								
01-Sep-84	6.1	6.1	9.75	10	96	101	46	50	4.55	5.35	3.35	4.05	91.5	104						
11-0ct-84	7.45	7.45	8	20.5	55	56	66.5	74	4.25	4.9	1.95	2.3	18.75	20.25						
03-Nov-84	7.15	7.25	11.9	14.25	63	71.3	38.5	39	5.45	5.65	4.6	4.8	5	5						

Table A.3 continued

Date	pH		Chloride		T. Alkalinity		TSS		D.O.		BOD		COD		NH_3		Coli-colonies		Chromium	
10-Dec-84	7.2	7.3	28	33	110	124	52	54	5.9	6.45	5.15	5.75								
01-Jan-85	7.45	7.6	23.5	31	140	144	76.5	79	5.2	5.4	2.3	2.35	9.5	10						
03-Feb-85	7.15	7.2	35.5	36.5	154	158	85.5	98	2.5	3.05	1.09	1.95	16	20						
02-Mar-85	6.1	6.1	57.5	63.5	142	150	113	114	2.85	3	1.8	1.95	23.5	25.5						
02-Apr-85	6.05	6.15	37	52.5	144	153	79	81	3.1	3.15	2	2	24	28						
07-May-85	6.?5	6.45	21.5	25	143	148	73.5	77	4.9	5.15	3.05	3.25	23.5	29						
02-Jun-85	6.8	7.1	19	22.5	146	152	78	79.5	5.5	5.8	2.45	3.55	22	27						
05-Aug!-85	6.85	6.85	6	6.25	46	47	19.5	30.5	4.5	4.65	1.55	1.8								
04-Sep-85	6.1	6.2	5.75	5.75	33	37	20.5	25.5	4.9	5	2.75	3!								
08-Oct-87	6.8	7	1.2	2.3	84	90	38	46	4.8	5.3	1.8	2.1								
14-Jan-88	6.8	7	8	12	90	94	45	55	5	6	2.1	8.2	44.2	51						
24-Feb-88	6.8	7.1	30	38	148	152	107	114	5	6.2	3	3.2	50.7	57						
04-May-88	6.75	7	43.5	46.5	122	126	74	114	1.7	4	3.5	50								
25-Jun-88	6.8	6.9	12.5	15.5	36	40	32	39	5.1	5.2	1.7	2								
05-Jul-88	6.8	6.9	11.5	12.5	24	36	15	22	4.9	5.1	I	1.8								
11-Aug-88	7.1	7.2	7.8	8	46	50	22	25												
06-Nov-88	7.2	7.3	9	12	42	46	25	26	6	6.5	1.6	2.1								
01-Dec-88	7.3	7.3	9	10	23	25	28	30	4.7	5	I	1.2								
10-Jan-89	7.2	7.4	16	18	136	140	48	57	4.7	4.9	2.3	2.8								
11-Feb-89	7.2	7.4	35	36	176	180	40	50	5	5.2	0.2	I								
14-Mar-89	7.3	7.4	35	37	172	176	33	50	4.9	5.1	0.9	1.1								
05-Apr-89	7.2	7.3	35	38	172	180	35	38	5	5.2	0.8	I								
10-May-89	7.3	7.4	36	39	168	172	50	52	4.9	5.1	1.5	1.8								
07-Jun-89	7.1	7.2	27	31	124	13?	49	51	5	5.3	1.1	1.9								
02-Jul-89	7	7.2	14	16	52	64	50	55	5.5	5.9	0.9	1.2								
05-Sep-89	7.1	7.3	25	29	56	68	33	36	6.3	6.8	1.9	2.1								

Table A.3 continued

Date	pH		Chloride		T. Alkalinity		TSS		D.O.		BOD		COD		NH_3		Coli-colonies		Chromium	
08-Nov-89	7.3	7.4	28	31	80	96	30	32	6	6.3	2.4	3.5								
06-Mar-90	7.5	7.6	40	44	128	148	45	47	6	6.2	2.1	2.5								
04-Apr-90	7.4	7.6	46	50	144	152	49	52	6.1	6.4	2.4	2.7								
06-May-90	7.3	7.4	48	52	160	168	47	50	6.2	6.6	1.9	2.3								
02-Jun-90	7.2	7.4	45	49	144	156	44	46	6	6.3	2	2.3								
06-Aul-90	7	7	26	28	80	92	77	80	6.7	7	1.7	2.2								
04-Sep-90	7.1	7.2	27	29	92	\00	52	55	5.9	6.2	1.7	2								
07-Nov-90	7.3	7.5	30	32	96	112	46	50	6	6.3	1.8	2.4								
03-Dec-90	7.3	7.4	19	22	92	108	25	28	6	6.3										
08-Jan-91	7.3	7.4	24	28	112	118	28	66	6.7	6.9										
09-Mav-91	7	7.2	25.5	31	112	114	30	33	5.4	5.7	3.1	3.3								
08-Jun-91	6.7	7	5	7	40	42	40	47	5.1	5.6	2.8	3								
11-Jul-91	6.6	6.8	5	8	40	44	52	53	5.2	5.5	2.5	2.8								
10-Apr-92	7.4	7.5	15.5	17	60	68	23	25	5.9	6.2	2.3	2.8								
06-Jun-92	7.5	7.5	13.5	15.5	126	140	32	35	5.9	6.3	2.3	2.7								
04-Jul-92	7.1	7.3	13	14.5	120	124	45	46	5.9	6.1	2.4	2.9								
06-Aug-92	6.9	7	12.5	13.5	112	116	48	54	6.1	6.4	1.9	2.3								
24-Sep-92	7.2	7.5	14	15	116	128	48	52	6	6.2	1.9	2.2								
05-Oct-92	7.3	7.6	16	18.5	124	136	58	61	5.5	6	2.7	3.5								
11-Nov-92	7.5	7.7	20	21	92	100	8	32	5.3	5.8	3	3.5							0	0
12-Dec-92	7.5	7.6	21	21.5	100	104	20	24	5.7	6.1	2.4	2.8							0	0
21-Apr-93	7.4	7.6	20	21.5	104	112	28	32	5.5	5.8	3.2	3.7								
27-Jun-93	7	7.3	14	15	108	116	38	42	6	6.6	2.8	3.2								
04-Jul-93	6.7	6.8	17.5	18.5	72	80	55	61	6.2	6.6	2	2.9								
08-Aug-93	6.7	7.1	13.5	14.5	48	68	55	58	6.2	6.6	3.2	3.5								
07-Sep-93	6.6	7	13	13.5	52	64	46	50	5.5	5.7	2.5	3.1							0.01	0.03
04-Oct-93	7.1	7.2	15	15.5	68	72	46	50	5	5.3	1.8	2.9								

Table A.3 continued

Date	pH		Chloride		T.Alkalinity		TSS		D.O.		BOD		COD		NH_3		Coli colonies		Chromium	
03-Nov-93	7	7.1	17.5	19.5	82	88	40	44	5.6	5.9	2.8	3.2								
02-Mar-94	6.9	7.3	19	21	88	96	26	31	4.4	4.8	1.8	2.2								
06-Jun-94	7.2	7.4	15	16	154	156	35	38	4.3	4.6	1.1	1.2								
04-Jul-94	6.9	7.2	10	12	58	62	40	45	6.4	6.8	2.4	3								
02-Aug-94	6.9	7.2	10	14	46	50	42	47	6	6.4	3.3	3.6								
03-0ct-94	7.1	7.2	16	20	58	64	30	34	5.7	5.9	3.8	4.2								
13-Dec-94	7.4	7.6	16	17.5	64	68	38	44	3.2	4	3	3.5								

Note: All parameters are in mg/l except pH and Coliform
Coliforms in 1000/ 100 ml of water

Table A.4 Water Quality at Pagla on the Buriganga River (Source : Kamal, 1996)

Date	pH		Chloride		T.Alkalinity		TSS		DO		BOD		COD		NH3		Coli-colonies		Chromium	
09-Aug-88	7.1	7.2	5	5.5	54	58	24	30												
16-Oct-88	7	7.1	7	8	80	88	40	53	5.9	6.3	2	2.2								
15-Nov-88	7.1	7.2	12	14	140	190	70	72	5.1	5.3	1.9	2								
07-Dec-88	7.3	7.4	26	30	24	36	52	54	5.2	5.5	2.3	4.1								
17-Jan-89	7.3	7.4	20	21	84	88	42	43	6.1	6.7	2.8	3.2								
08-Feb-89	7.2	7.2	27	29	200	204	42	50	4.9	5	1.1	2.6								
18-Mar-89	7.3	7.4	36	37	172	188	42	50	5	5.1	2.8	3								
27-Apr-89	7.3	7.4	39	40	182	200	28	32	5.6	5.9	2.6	2.8								
15-May-89	7.4	7.4	38	42	180	184	42	44	5	5.3	2.4	2.6								
08-Jun-89	7.1	7.3	29	32	136	140	33	36	5.1	5.5	1.5	1.8								
05-Jul-89	7	7.1	12	14	60	72	40	47	5.1	5.5	1.1	1.4								
19-Feb-90	7.4	7.5	36	39	120	136	36	39	6.1	6.3	1	1.3								
II-Mar-90	7.4	7.5	39	42	128	140	38	44	6	6.3	2.5	2.8								
16-Apr-90	7.3	7.4	45	49	144	156	47	52	6	6.2	1.4	2.6								
20-May-90	7.3	7.4	47	51	156	168	44	45	6.2	6.4	1.9	2.2								
09-Jun-90	7.2	7.3	44	48	136	148	48	50	6.1	6.4	1.8	2.2								
13-Aug-90	6.9	7	26	29	52	60	62	70	6.3	6.5	1.8	2.2								
11-Sep-90	7.1	7.2	26	30	56	68	50	52	6.1	6.6	1.5	1.8								
22-Oct-90	7	7.2	30	33	64	76	47	49	6.7	7	1.2	1.6								
13-Nov-90	7.1	7.3	31	34	68	80	42	45	6.7	7	1.2	1.6								
17-Dec-90	7.2	7.3	29	30	68	72	27	30	6	6.2										
20-May-91	6.6	6.8	5.5	6	42	48	41	44	6	6.6	2.1	2.4								
21-Aug-91	7.1	7.3	7	7.5	50	54	23	26	6.3	6.6	2	2.5								
17-Nov-91	6.9	7	8	9.5	44	50			6	6.4	2	2.5								
03-Dec-91	6.9	7.2	9	10.5	50	56			6	6.3	3	3.5								
09-Jul-92	7	7.2	12	13	112	120	40	42	6	6.2	3	3.8								

Table A.4 continued

Date	pH		Chloride		T. Alkalinity		TSS		DO		BOD		COD		NH3		Coli-colonies		Chromium	
25-Aug-92	7	7.3	11	12.5	108	120	44	48	6.1	6.5	3	3.5								
14-Sep-92	7.2	7.3	12	13.5	120	128	49	52	6	6.4	2	2.3								
25-Oct-92	7.3	7.6	10	11	116	132	30	35	5.3	5.8	3.8	4.2								
25-Nov-92	7.4	7.5	11.5	12	136	140	27	30	6.2	6.5	4	4.4								
05-Dec-92	7.5	7.6	11	12.5	136	148	24	28	5.6	5.8	3.4	3.8								
25-Apr-93	7.3	7.5	16.5	18	144	156	36	38	5.1	5.4	3.4	3.8								
14-Jun-93	6.9	7.1	15.5	17	132	140	47	56	5.7	5.9	3.3	3.8								
20-Jul-93	6.7	6.8	12.5	14	104	116	85	98	6.4	6.7	3.2	3.8								
21-Aug-93	6.6	7.9	10	11	48	84	60	164	6	6.5	3.5	3.9								
29-Sep-93	7	7.2	12.5	13.5	80	92	47	52	7.2	7.4	2.8	3.4								

Note: All parameters are in mg/l except pH and Coliform
Coliforms in 1000/ 100 ml of water

Table A.5: Water Quality Data Measured by Department of Environment (DOE) (Source: IWM, August 2004)

Station/River	Date	Time	Turbidity (NTU)	Temp 0C	DO (mg/l)	BOD5 at 200C (mg/l)	COD (mg/l)	pH	EC (micro S/cm)	Total Alkinity (mg/l)
Mirpur Bridge	30/1/2000	9:00	28	23.6	5	1.5	4	7.15	540	125
Turag River	24/2/2000	9:00	50	24	4.1	3.5		7.5	612	170
	28/3/2000	9:30	36	27	4	6		7.55	630	172
	18/4/2000	9:00	39	28	5	1.8		7.35	598	160
	28/5/2000	9:00	32	28	5.9	2.4		7.1	320	68
	25/6/2000	9:15	28	29	6	3		7.1	248	56
	24/7/2000	9:00	55	29.5	7.5	0.8		7.1	147	52
	24/8/2000	9:15	58	30	7.6	1.2		7.12	140	48
	24/9/2000	9:00	30	29.5	5.8	1.8		7.1	148	56
	24/10/2000	9:15	28	29.5	6.8	2.2		6.72	158	58
	29/11/2000	10:00	35	26	5.9	2		6.99	198	72
	21/12/2000	9:30	<25	24	5.1	1.8		7.1	236	84
	29/1/2001	8:00	28	23.6	5	1.5	4	7.15	540	125
	28/2/2001	9:00	26	23.9	6.2	5	68	7.4	580	90
	29/3/2001	9:00	8	29.2	6.4	5		7.1	420	68
	26/4/2001	10:15	9.5	30.2	6	4.5		7.1	400	70
	20/5/2001	9:30	8	30	6.4	5		7.2	420	68
	15/7/2001	10:00	9.5	29	6.7	4.6		7.1	402	70
	26/8/2001		12	29.5	6.8	3.8		7.2	150	38
	16/9/2001		8	29	6.9	3.8		7.25	160	48
	31/10/2001	12:00	8	28	6.3	2.8		6.9	172	50
	25/11/2001	10:00	4	25	6.4	2.7		6.8	172	24
	20/12/2001		5	21.5	5	1.6		6.92	178	26
	20/1/2002		4.8	22	4.6	3.3		7.16	534	72
	28/2/2002		6.3	23	3.4	10		7.15	540	74
	12/3/2002	10:30	7.5	27	3	8		7.18	580	72
	22/4/2002	10:00	9	29.5	4.6	10		7.15	560	70
	28/5/2002	10:00	8	28.8	6.2	3.7		6.95	450	60
	17/6/2002	10:00	10	28	6.3	3.6		6.9	190	48
	14/7/2002	9:10	10	27.2	6.8	3.7		6.9	106	40
	10/8/2002	9:30	10	28	6.7	3.4		6.91	120	48
	30/9/2002	9:50	10	27.8	6.8	3.4		7.1	142	50
	26/10/2002	9:10	8.5	27.5	6.4	3.2		7.1	170	52

Table A.5 continued

Station/River	Date	Time	Turbidity (NTU)	Temp 0C	DO (mg/l)	BOD5 at 200C (mg/l)	COD (mg/l)	pH	EC (micro S/cm)	Total Alkinity (mg/l)
Mirpur Bridge Turag River	30/12/2002	9:30	6.5	23.8	6.2	3		7.15	196	68
	18/1/2003	9:30	6	20	4.8	2.7		7.18	480	72
	23/2/2003	9:45	4.5	23	5.6	2		7.22	520	80
	16/3/2003	9:30	4.5	29	4	8		7.24	588	88
Hazaribagh Buriganga	30/1/2000	10:00	38	23.6	4	10	36	7.4	562	218
	24/2/2000	10:00	38	24	3.3	7		7.8	708	192
	28/3/2000	10:30	34	27	3.1	7		7.79	740	189
	18/4/2000	10:00	38	28	3.5	6.5		7.55	730	170
	28/5/2000	10:00	42	28	3	18		7.4	400	132
	25/6/2000	10:10	36	29	4.8	10		7.38	390	110
	24/7/2000	10:00	47	29.5	7.3	0.8		7.2	141	54
	24/8/2000	10:30	50	30	7.2	1.4		7.25	155	56
	24/9/2000	10:00	32	29.5	5.2	1.7		7.25	154	58
	24/10/2000	10:15	30	29.5	6.6	2.1		6.8	156	56
	29/11/2000	11:00	36	26	5.4	1.8		7.3	250	86
	21/12/2000	10:30	<25	24	4.9	1.6		7.36	260	98
	29/1/2001	9:10	38	23.6	4	10	36	7.4	762	218
	28/2/2001	9:45	27	23.9	1.5	26	120	7.45	600	160
	29/3/2001	9:30	9.8	29.2	2.8	18		7.2	450	72
	26/4/2001	11:15	10	30.2	2.4	12		7.3	430	78
	20/5/2001	10:45	9.8	30	2.8	18		6.9	450	72
	15/7/2001	12:00	12	29	6.2	3.8		7.2	428	78
	26/8/2001		14	29.5	6.7	4		7.3	180	48
	16/9/2001		12	29	6.7	3.6		7.35	190	60
	31/10/2001	12:45	12	28	6.5	2.8		7.1	205	62
	25/11/2001	11:00	4.5	25	6	2.9		7.1	189	25
	20/12/2001		6.5	21.5	4.8	6		7.4	198	34
	20/1/2002		6	22	1.2	12		7.21	744	80
	28/2/2002		6.5	23	1.1	14		7.21	750	84
	12/3/2002	12:00	9	27	1	16		7.3	720	86
	22/4/2002	11:00	12	29.5	2	14		7.32	700	90
	28/5/2002	11:00	9.5	28.8	5.2	3		7.4	580	72
	17/6/2002	11:00	12	28	5.3	3.1		7.18	260	58
	14/7/2002	10:20	12	27.2	6	2		7.2	240	56
	10/8/2002	10:30	12	28	6	2.8		7.25	250	65

Table A.5 continued

Station/River	Date	Time	Turbidity (NTU)	Temp.0C	DO (mg/l)	BOD5 at 200C (mg/l)	COD (mg/l)	pH	EC (micro S/cm)	Total Alkinity (mg/l)
Hazaribagh Buriganga	30/9/2002	10:40	12.5	27.8	6	3		7.26	236	68
	26/10/2002	10:00	10	27.5	6	2.8		7.25	240	62
	30/12/2002	10:30	8.5	23.8	5.8	2.6		7.28	290	80
	18/1/2003	10:30	16	20	1.6	14		7.3	700	120
	23/2/2003	10:30	10	23	1.4	16		7.34	720	126
	16/3/2003	10:30	8	29	1.2	20		7.48	764	150
Kamrangir Char Buriganga	30/1/2000	10:25	28	23.6	5.4	2.2	7	7.18	560	140
	24/2/2000	10:35	30	24	3.8	6		7.7	664	178
	28/3/2000	11:00	30	27	3.5	7.5		7.72	680	180
	18/4/2000	10:25	32	28	3.9	6		7.4	.600	162
	28/5/2000	10:25	30	28	5.9	3.8		6.9	322	60
	25/6/2000	10:35	30	29	6.1	3.2		6.9	250	52
	24/7/2000	10:20	68	29.5	7.5	0.7		6.98	144	54
	24/8/2000	10:45	60	30	7.6	0.9		7.1	132	46
	24/9/2000	10:25	30	29.5	5.6	1		6.9	145	54
	24/10/2000	10:35	32	29.5	6.7	1.8		6.82	144	56
	29/11/2000	11:25	30	26	6	2.1		7.1	200	74
	21/12/2000	10:45	<25	24	5.2	2		7.18	240	86
	29/1/2001	10:20	28	23.6	5.4	2.2	7	7.18	560	140
	28/2/2001	10:30	30	23.9	1.8	15	72	7.5	720	140
	29/3/2001	10:30	9.6	29.2	3.8	12		7.25	430	70
	26/4/2001	11:35	10.5	30.2	4	10		7.2	410	76
	20/5/2001	11:15	9.6	30	3.8	12		7.3	430	70
	15/7/2001	12:45	10	29	6.6	4		7.2	408	76
	26/8/2001		16	29.5	6.9	4		7.1	130	42
	16/9/2001		6	29	6.8	4		7.13	120	50
	31/10/2001	13:00	8	28.5	6.4	3.7		7.2	132	50
	25/11/2001	12:00	3.5	25	6.5	2.6		7.1	171	24
	20/12/2001		6	21.5	5.2	2.2		7.1	176	30
	20/1/2002		4.5	22	1.4	8		7.27	596	76
	28/2/2002		6	23	1.3	12		7.25	600	82
	12/3/2002	13:45	7	27	2.1	10		7.2	590	70
	22/4/2002	11:40	10	29.5	2.8	8		7.2	565	76
	28/5/2002	11:30	7.5	28.8	6.4	3.8		7.1	480	66
	17/6/2002	12:00	10	28	6.3	3.7		7.1	200	50

Table A.5 continued

Station/River	Date	Time	Turbidity(NTU)	Temp 0C	DO (mg/l)	BOD5 at 200C(mg/l)	COD(mg/l)	pH	EC(micro S/cm)	Total Alkinity(mg/l)
Kamrangir Char Buriganga	14/7/2002	11:00	10	27.2	6.7	3.7		7.1	120	48
	10/8/2002	11:20	10.5	28	6.8	3.5		7.12	126	56
	30/9/2002	11:35	10.5	27.8	6.8	3.3		7.13	148	52
	26/10/2002	11:10	8	27.5	6.2	3		7.14	176	56
	30/12/2002	11:20	6	23.8	5.9	2.8		7.15	210	70
	18/1/2003	11:20	5	20	2.4	8		7.26	510	80
	23/2/2003	11:20	4	23	2.2	10		7.2	510	78
	16/3/2003	11:20	4.5	29	2	16		7.25	580	88
Chandnighat Buriganga	30/1/2000	10:40	30	23.6	5.1	2.1	6	7.2	565	142
	24/2/2000	10:55	32	24	3.5	24		7.4	677	180
	28/3/2000	11:15	30	27	3.4	18		7.45	675	182
	18/4/2000	10:40	30	28	4	10		7.38	610	160
	28/5/2000	10:40	32	28	6.1	4.9		6.95	318	66
	25/6/2000	11:10	28	29	6.2	3.4		6.98	230	54
	24/7/2000	10:35	67	29.5	5.5	0.7		7.05	150	52
	24/8/2000	11:00	65	30	7	0.9		7.12	148	50
	24/9/2000	10:40	32	29.5	5.5	1.8		6.92	138	56
	24/10/2000	10:50	30	29.5	6	1.4		6.8	148	54
	29/11/2000	11:40	28	26	6.1	2.2		6.98	198	72
	21/12/2000	11:10	<25	24	5..1	2		7.1	238	85
	29/1/2001	11:30	30	23.6	5.1	2.1	6	7.2	565	142
	28/2/2001	11:20	28	23.9	2	12	68	7.39	650	110
	29/3/2001	11:10	9.7	29.2	6	4		7.1	440	74
	26/4/2001	12:10	12	30.2	5	3.8		7.1	402	80
	20/5/2001	11:35	9.7	30	6	4		7.2	440	72
	15/7/2001	13:15	9	29	6.8	4		7.1	400	80
	26/8/2001		15	29.5	7	4.5		6.98	138	44
	16/9/2001		10	29	6.9	4.1		7.1	142	52
	31/10/2001	13:25	12	28	6	3.5		7.2	151	54
	25/11/2001	13:05	40	25	6.4	3.4		7.2	173	26
	20/12/2001		6	21.5	5.8	2		7.15	176	28
	20/1/2002		6.5	22	1.2	10		7.25	600	74
	28/2/2002		10	23	1.1	10		7.2	615	74
	12/3/2002	14:20	8	27	1.4	12		7.25	600	72
	22/4/2002	12:30	10.5	29.5	2.4	12		7.2	568	74

Table A.5 continued

Station/River	Date	Time	Turbidity(NTU)	Temp0C	DO(mg/l)	BOD5at200C(mg/l)	COD(mg/l)	pH	EC(micro S/cm)	Total Alkinity(mg/l)
Chandnighat Buriganga	28/5/2002	12:00	8	28.8	6.3	3.8		7.1	490	64
	17/6/2002	13:00	12	28	6.4	3.7		6.95	210	52
	14/7/2002	12:00	10	27.2	6.8	3.8		6.95	122	46
	10/8/2002	12:00	10.5	28	6.7	3.5		6.92	128	54
	30/9/2002	12:20	10	27.8	6.8	3.4		7.12	146	50
	26/10/2002	12:00	8.5	27.5	6.4	3.1		7.12	174	54
	30/12/2002	12:00	6	23.8	6	2.8		7.15	200	72
	18/1/2003	12:00	5	20	2.6	6		7.2	500	76
	23/2/2003	12:00	4.5	23	2.4	10		7.2	520	76
	16/3/2003	12:00	4	29	2.2	14		7.25	584	88
Sadarghat Buriganga	30/1/2000	10:55	28	23.6	5.3	2.4	8	7.2	560	146
	24/2/2000	11:05	30	24	3.2	23		7.4	859	178
	28/3/2000	11:30	32	27	3.1	18.5		7.4	662	169
	18/4/2000	10:55	30	28	4	16		7.3	600	162
	28/5/2000	11:00	30	28	5.5	4.2		66.98	320	64
	25/6/2000	11:10	28	29	6.2	3.2		6.98	240	54
	24/7/2000	11:00	95	29.5	7.5	2.1		7.08	152	56
	24/8/2000	11:20	90	30	7.2	2.4		7.1	145	49
	24/9/2000	10:55	36	29.5	5.7	1.7		6.95	139	54
	24/10/2000	11:05	38	29.5	5.8	1		6.95	150	54
	29/11/2000	12:00	30	26	6	2		7.12	198	74
	21/12/2000	11:30	<25	24	5.2	2.1		7.15	236	86
	29/1/2001	12:45	28	23.6	5.3	2.4	8	7.2	560	146
	28/2/2001	12:10	28	23.9	2.1	10	74	7.35	630	100
	29/3/2001	12:00	9.8	29.2	5.8	3		7.13	438	72
	26/4/2001	12:30	11	30.2	5.2	4		7.1	400	72
	20/5/2001	11:50	9.8	30	5.8	3		7.2	435	70
	15/7/2001	13:45	10	29	6.1	4.1		7	412	74
	26/8/2001		12	29.5	7	4.6		6.95	135	46
	16/9/2001		8	29	7	4.2		7.15	130	56
	31/10/2001	13:40	8	27	5.5	2.8		7.2	135	60
	25/11/2001	13:30	5	25	6.1	3.4		7.2	172	24
	20/12/2001		8	21.5	4.6	6		7.25	180	30
	20/1/2002		6.5	22	1.6	10		7.18	600	74
	28/2/2002		4.9	23	1.1	12		7.15	610	72

Table A.5 continued

Station/River	Date	Time	Turbidity(NTU)	Temp0C	DO(mg/l)	BOD5at 200C(mg/l)	COD(mg/l)	pH	EC(micro S/cm)	Total Alkinity(mg/l)
Sadarghat Buriganga	12/3/2002	14:45	8	27	1.1	14		7.2	620	72
	22/4/2002	13:15	10.5	29.5	2.6	12		7.28	570	76
	28/5/2002	13:15	8.5	28.8	6.4	3.8.		7.12	480	66
	17/6/2002	13:30	12.5	28	6.1	3.5		6.98	200	52
	14/7/2002	12:40	12	27.2	6.9	3.8		6.96	124	46
	10/8/2002	13:45	10	28	6.8	3.6		6.95	128	54
	30/9/2002	13:15	10	27.8	6.8	3.4		7.14	146	52
	26/10/2002	12:40	8.5	27.5	6.4	3.1		7.14	178	56
	30/12/2002	12:50	6	23.8	6	2.8		7.14	206	72
	18/1/2003	12:40	4.5	20	2.8	8		7.18	500	74
	23/2/2003	13:00	4.5	23	2.6	8		7.21	528	78
	16/3/2003	13:00	4	29	2.4	14		7.26	586	90
Farasganj Buriganga	30/1/2000	11:10	30	23.6	4.9	1.9	4	7.18	562	142
	24/2/2000	11:30	30	24	3.1	22		7.3	642	172
	28/3/2000	11:45	30	27	3	16		7.32	650	170
	18/4/2000	11:10	32	28	3.6	14		7.38	620	162
	28/5/2000	11:20	30	28	5.4	4		7.15	316	64
	25/6/2000	11:25	30	29	6	2.9		7.1	248	56
	24/7/2000	11:10	97	29.5	7.5	2.1		7.15	142	54
	24/8/2000	11:35	92	30	7.2	2.8		7.2	150	52
	24/9/2000	11:10	35	29.5	5.7	1.3		7.09	140	52
	24/10/2000	11:20	32	29.5	6.8	1.4		6.89	156	52
	29/11/2000	12:15	28	26	5.8	1.8		7.15	202	78
	21/12/2000	11:45	<25	24	5	1.9		7.18	242	88
	29/1/2001	12:00	30	23.6	4.9	1.9	4	7.18	562	142
	28/2/2001	13:00	26	23.9	1.9	16	78	7.4	640	98
	29/3/2001	13:00	9.4	29.2	5	2.8		7.15	420	76
	26/4/2001	12:45	10	30.2	4.8	8		7.2	400	70
	20/5/2001	12:05	9.4	30	5	2.8		6.9	420	74
	15/7/2001	14:20	12	29	6.2	3.8		7.1	401	72
	26/8/2001		16	29.5	6.7	3.8		7.1	140	44
	16/9/2001		8.5	29	6.8	3.8		7.2	146	58
	31/10/2001	14:00	9	27	5.5	2.7		7.9	156	62
	25/11/2001	14:00	3	25	5.5	2.7		7.8	176	28
	20/12/2001	[illegible]	8.5	21.5	4.2	8		7.38	192	32

Table A.5 continued

Station/River	Date	Time	Turbidity (NTU)	Temp 0C	DO (mg/l)	BOD5 at 200C(mg/l)	COD(mg/l)	pH	EC(micro S/cm)	Total Alkinity(mg/l)
Farasganj Buriganga	20/1/2002		7	22	1	10.5		7.11	628	80
	28/2/2002		4.8	23	1.2	10		7.11	630	82
	12/3/2002	15:00	6	27	1.2	12		7.3	650	76
	22/4/2002	14:00	9.5	29.5	2	14		7.3	600	78
	28/5/2002	14:00	8.5	28.8	6	3.6		7.15	486	68
	17/6/2002	14:15	10	28	5.3	2.9		7.1	216	54
	14/7/2002	13:30	10	27.2	6.8	3.8		6.98	120	44
	10/8/2002	14:30	12	28	6.7	3.4		6.95	138	58
	30/9/2002	14:20	10	27..8	6.7	3.2		7.18	160	54
	26/10/2002	13:30	9	27.5	6.3	3		7.15	190	58
	30/12/2002	13:30	6.5	23.8	5.9	2.7		7.16	204	70
	18/1/2003	13:20	10	20	2.2	10		7.2	580	76
	23/2/2003	14:40	4.8	23	2.2	10		7.25	568	80
	16/3/2003	14:00	5	29	2.1	16		7.3	626	96
Dholaikhal Buriganga	30/1/2000	11:20	35	23.6	4.1	6	18	7.2	750	168
	24/2/2000	11:40	35	24	2	14		8	712	184
	28/3/2000	12:00	38	27	2.1	12		8	700	185
	18/4/2000	11:20	32	28	3.6	14		7.5	672	168
	28/5/2000	11:30	38	28	4	10		7.3	390	120
	25/6/2000	11:35	38	29	4.9	8		7.3	380	105
	24/7/2000	11:20	85	29.5	6	0.7		6.95	145	54
	24/8/2000	11:45	110	30	7.2	0.9		7.2	155	52
	24/9/2000	11:20	34	29.5	5.4	0.8		7.1	142	60
	24/10/2000	11:30	30	29.5	5.5	0.9		6.88	150	58
	29/11/2000	12:30	32	26	5.6	1.6		7.2	230	82
	21/12/2000	12:00	<25	24	4.8	1.4		7.3	270	96
	29/1/2001	1:00	35	23.6	4.1	6	18	7.2	750	168
	28/2/2001	14:00	30	23.9	1.5	20	100	7.5	668	150
	29/3/2001	13:30	16	29.2	3.2	10		7.2	452	86
	26/4/2001	12:55	12	30.2	2.8	18		7.3	428	92
	20/5/2001	12:15	16	30	3.3	10		7	446	78
	15/7/2001	14:40	12.5	29	6.1	3.6		7.3	430	90
	26/8/2001		18	29.5	6.2	3.7		7.3	190	50
	16/9/2001		10	29	6.5	3.2		7.3	160	62
	31/10/2001	14:15	11	27	5.5	2.8		7.8	180	65

Table A.5 continued

Station/River	Date	Time	Turbidity (NTU)	Temp 0C	DO (mg/l)	BOD5 at 200C(mg/l)	COD(mg/l)	pH	EC(micro S/cm)	Total Alkinity(mg/l)
Dholaikhal Buriganga	25/11/2001	14:00	6	25	5.6	2.8		7.7	181	24
	20/12/2001		6	21.5	5.2	1.6		7.2	180	28
	20/1/2002		8	22	1	16		6.96	721	92
	28/2/2002		10	23	1	12		6.98	720	94
	12/3/2002	15:15	8.5	27	0.8	18		7.35	760	82
	22/4/2002	14:40	12	29.5	1.8	18		7.35	690	80
	28/5/2002	14:45	9.5	28.8	5.1	2.8		7.25	550	70
	17/6/2002	15:00	12	28	6.3	3.3		7.15	240	56
	14/7/2002	14:10	12.5	27.2	5.8	2.1		7.25	236	60
	10/8/2002	15:10	15	28	5.8	2.8		7.15	248	62
	30/9/2002	15:00	15.5	27.8	5.9	2.8		7.22	240	56
	26/10/2002	14:00	12	27.5	6	3		7.23	242	64
	30/12/2002	14:10	10	23.8	5.8	2.4		7.25	298	86
	18/1/2003	14:00	6.5	20	1.8	12		7.28	680	90
	23/2/2003	15:30	10.5	23	1.6	12		7.28	686	84
	16/3/2003	14:50	6.5	29	1.6	18		7.36	700	120
BD-China Bridge Buriganga	30/1/2000	12:20	30	23.6	5	2	7	7.18	564	130
	24/2/2000	12:40	28	24	2.6	14		7.7	630	170
	28/3/2000	12:25	30	27	2.5	12		7.6	675	169
	18/4/2000	12:30	30	28	4	10		7.35	610	160
	28/5/2000	12:30	30	28	5.6	3.8		7.1	324	64
	25/6/2000	12:25	28	29	6.2	3.1		7.1	246	54
	24/7/2000	12:20	100	29.5	7.3	1.6		6.98	143	55
	24/8/2000	12:45	50	30	7.4	2.8		6.9	140	48
	24/9/2000	12:20	29	29.5	5.6	1.3		6.9	139	52
	24/10/2000	12:40	28	29.5	5.8	1.2		6.82	148	50
	29/11/2000	13:05	28	26	5.9	2		7.2	200	70
	21/12/2000	13:10	<25	24	5.2	2		7.22	242	82
	29/1/2001	14:00	30	23.6	5	2	7	7.18	564	130
	28/2/2001	14:50	26	23.9	4.6	8	70	7.3	620	94
	29/3/2001	14:45	12	29.2	4.2	8		7.1	400	78
	26/4/2001	13:15	10	30.2	5.5	3.9		7.2	446	74
	20/5/2001	12:50	12	30	4.4	8		7.1	410	86
	15/7/2001	15:30	12	29	6.5	3.2		7.2	445	72
	26/8/2001	[illegible]	16.5	29.5	6.3	3.8		7.15	182	40

Table A.5 continued

Station/River	Date	Time	Turbidity(NTU)	Temp0C	DO(mg/l)	BOD5 at 200C(mg/l)	COD(mg/l)	pH	EC(microS/cm)	Total Alkinity(mg/l)
BD-China Bridge Buriganga	16/9/2001		12	29	6.7	3.4		7.1	150	52
	31/10/2001	14:25	12	27	5	3		7.4	160	54
	25/11/2001	15:15	5	25	6	2.9		7.3	173	24
	20/12/2001		6.5	21.5	5.1	1.4		7.25	182	32
	20/1/2002		4.5	22	1.4	8.5		7.17	624	76
	28/2/2002		4.9	23	1.1	12		7.15	630	78
	12/3/2002	15:45	6	27	1	14		7.18	640	74
	22/4/2002	15:30	10	29.5	2.2	14		7.2	630	78
	28/5/2002	15.15	6.5	28.8	6.2	3.4		7.1	460	60
	17/6/2002	15:45	10	28	6.2	3.1		6.9	220	50
	14/7/2002	15:00	12.5	27.2	6.7	3.6		6.9	122	44
	10/8/2002	16:00	10	28	6.8	3.6		6.92	126	58
	30/9/2002	15:30	10.5	27.8	6.9	3.6		7.1	144	50
	26/10/2002	15:10	9	27.5	6.4	3.2		7.11	172	52
	30/12/2002	15:00	6	23.8	6	3		7.1	200	72
	18/1/2003	15:00	5	20	2.6	8		7.25	520	82
	23/2/2003	16:20	4.5	23	2.4	10		7.21	540	76
	16/3/2003	15:30	4.5	29	2.4	12		7.28	590	92
Pagla Buriganga	30/1/2000	13:15	30	23.6	5.2	2.1	8	7.2	565	136
	24/2/2000	13:35	30	24	3.2	10		7.8	583	160
	28/3/2000	13:20	30	27	3.1	8		7.75	620	164
	18/4/2000	13:25	32	28	4.1	8		7.35	610	162
	28/5/2000	13:25	32	28	5.4	3.6		7.18	328	68
	25/6/2000	13:30	30	29	6.2	3.2		7.1	240	56
	24/7/2000	13:15	95	29.5	8.5	3.6		6.92	149	596
	24/8/2000	14:00	52	30	7.4	4.2		6.99	142	50
	24/9/2000	13:15	28	29.5	5.5	1.5		6.99	142	54
	24/10/2000	13:30	28	29.5	6	1.4		6.8	144	54
	29/11/2000	14:15	30	26	5.8	1.8		7.71	206	75
	21/12/2000	14:05	<25	24	5.1	1.9		7.25	246	84
	29/1/2001	15:00	30	23.6	5.2	2.1	8	7.2	565	136
	28/2/2001	15:30	26	23.9	3.2	8.5	60	7.35	600	96
	29/3/2001	15:30	9.8	29.2	5.8	2.4		7.2	430	80
	26/4/2001	14:00	10.5	30.2	5.9	4.2		7.1	420	78
	20/5/2001	14:00	9.8	30	5.9	2.3		7.2	425	80

Table A.5 continued

Station/River	Date	Time	Turbidity (NTU)	Temp.0C	DO (mg/l)	BOD5 at 200C(mg/l)	COD(mg/l)	pH	EC(micro S/cm)	Total Alkinity(mg/l)
Pagla Buriganga	15/7/2001	16:45	10.5	29	6.4	4.1		7.1	418	78
	26/8/2001		15	29.5	6.7	4		7.1	142	46
	16/9/2001		8	29	6.6	3.5		7.15	158	56
	31/10/2001	14:45	9	28	4.6	3.9		7.4	168	60
	25/11/2001	16:00	5	25	5.8	3.8		7.4	173	32
	20/12/2001		6.5	21.5	5.1	1.4		7.25	182	32
	20/1/2002		4.5	22	1.2	10		7.13	630	80
	28/2/2002		4.8	23	1.5	10		7.12	632	82
	12/3/2002	16:00	6	27	1.2	12		7.18	640	74
	22/4/2002	16:30	10	29.5	2.4	12		7.18	620	72
	28/5/2002	16:00	7.5	28.8	6	3		7.15	488	62
	17/6/2002	16:30	10.5	28	6.5	1.1		6.95	212	54
	14/7/2002	16:00	10	27.2	6.8	3.8		6.98	124	46
	10/8/2002	16:40	10.5	28	6.7	3.5		6.94	130	60
	30/9/2002	16:10	12	27.8	6.7	3.2		7.15	150	54
	26/10/2002	16:00	8.5	27.5	6.2	3.1		7.15	174	56
	30/12/2002	16:00	6.5	23.8	5.8	2.8		7.15	208	76
	18/1/2003	16:00	6	20	2.8	8		7.18	520	76
	23/2/2003	17:00	4	23	2.6	8		7.2	530	76
	16/3/2003	16:20	4.5	29	2.2	14		7.28	596	94
Estema Ghat Demra Ghat Lakhya	22/1/2002	12:30	8	22.8	3	8.5		6.92	436	64
	13/1/2002		4.2	20.6	7.2	3.2		7.4	348	54
	12/2/2002	11:00	4.5	24	6.8	3.3		7.3	350	56
	18/3/2002	14:30	5	25	6.7	3.5		7.2	345	52
	4/4/2002	13:00	6.5	28.5	6.8	3.6		7.25	300	54
	21/5/2002	12:00	6.5	28.4	6.9	3.8		6.8	120	50
	23/6/2002	12:00	4	28	6.9	3.6		6.8	116	46
	22/7/2002	12:00	10	27.1	7	3.6		6.82	116	42
	12/8/2002	12:30	12	28	6.9	3.4		6.88	124	48
	8/9/2002	12:00	8	28.3	6.8	3.4		6.91	150	48
	28/10/2002	12:00	9	27.5	6.7	3.3		6.92	158	60
	24/11/2002	12:00	9.5	27	6.8	3.2		6.96	166	60
	28/12/2002	12:00	6.5		6.6	3		7.1	160	68
	19/1/2003	11:00	6	18	6.1	3		7.15	168	72
	24/2/2003	13:00	4.5	23	6	3.1		7.16	170	76

Table A.5 continued

Station/River	Date	Time	Turbidity (NTU)	Temp0C	DO(mg/l)	BOD5 at 200C(mg/l)	COD(mg/l)	pH	EC(micro S/cm)	Total Alkinity(mg/l)
Ghorashal (River)	26/1/2002		7.2	22	6.5	2.5		7.21	155	30
Lakhya	5/2/2002	12:00	8	22	6.4	2.5		7.21	160	48
	5/3/2002	12:00	9	27	6.5	2.4		7.11	155	80
	15/4/2002	13:00	6.5	29	6.7	2.6		7.25	160	32
	18/5/2002	12:00	8.5	28.5	6.8	3		7.15	120	38
	15/6/2002	12:30	12.5	28	6.9	3.1		7.1	124	40
	27/7/2002	13:30	10.5	27	7.2	3.2		6.92	110	42
	24/8/2002	12:30	10.5	28.1	7	3.4		6.94	140	56
	21/9/2002	13:00	10	28.5	6.9	3.2		6.95	148	60
	2/11/2002	13:30	9	27	6.8	3.3		7.1	158	150
	14/12/2002	14:00	8		6.7	3		7.1	150	66
Ghorashal (River)	26/1/2003	14:00	6.5	20	6.6	3.2		7.1	220	94
Lakhya	22/2/2003	13:30	5	23	6.2	3.1		7.1	240	100
Ghorashal (drain)	26/1/2002		3.2	22	4	10		8.8	3500	1000
Lakhya	5/2/2002	12:30	3.5	22	4.1	12		8.5	3580	1015
	5/3/2002	13:50	3.2	27	4.2	10		8.4	3540	1100
	15/4/2002	13:30		29				8.7	3580	1050
	18/5/2002	12:30	3.5	28.5	5.2	2.8		8.5	3000	1020
	15/6/2002	12:00	3.6	28	5.3	2.4	12.4	8.4	3200	1018
	27/7/2002	14:00	3.5	27	5.6	2.6	14.2	8.41	3000	1006
	24/8/2002	13:20	3.5	28.1	5.6	2.4	16	8.45	3280	1086
	21/9/2002	13:30	3.5	28.6	5.4	2	10.2	8.5	3500	1120
Ghorashal (drain)	2/11/2002	14:30	3.5	27	5.2	2	10.2	8.5	3560	1092
Lakhya	14/12/2002	14:30	3.5		5.2	2.1	10.4	8.56	3580	1150
	26/1/2003	14:30	3.5	20	5	5	10.2	8.6	3500	1160
	22/2/2003	14:40	3.5	23	5	2.8	12.4	8.52	3520	1164
Narayanganj ACI	15/1/2002		10	22	7	2.5		6.9	132	85
Lakhya	9/2/2002	12:00	10	24	7.2	3		6.95	136	90
	10/3/2002	13:30	10	27	6.9	3.5		6.96	140	86
	5/4/2002	12:00	9	29	6.9	4		7.1	150	80
	22/6/2002	11:30	4	28	6.9	3.5		7.21	425	190
	15/7/2002	12:30	10.5	27	7.2	3.6		6.9	120	80
	27/8/2002	12:40	9.5	28.1	7.1	3.5		6.95	146	82
	29/9/2002	12:00	8.5	28.5	7	3.4		6.96	150	88
	8/10/2002	13:00	10.5	28	7.1	4.1		6.92	140	88

Table A.5 continued

Station/River	Date	Time	Turbidity (NTU)	Temp 0C	DO (mg/l)	BOD5 at 200C(mg/l)	COD(mg/l)	pH	EC(micro S/cm)	Total Alkinity(mg/l)
Narayanganj ACI Lakhya	17/11/2002	13:20	9.5	26.6	7.3	3.6		7.1	150	96
	29/12/2002	12:30	7		6.7	3.1		7.12	156	86
	8/1/2003	12:00	4.5	18	5.9	2.8		7.12	200	100
	9/2/2003	13:00	5	23	5.8	2.7		7.15	160	120
Narayanganj ACI (Drain) Lakhya	15/1/2002		12	22	4	3.5		7.3	400	180
	9/2/2002	12:45	3.5	24	4.4	1.3		7.32	420	186
	10/3/2002	14:00	4	27	4.5	3.2		7.21	425	190
	5/4/2002	12:30	3	29	4.6	3		7.3	500	200
	22/6/2002	12:00	10	28	6.8	3.4	16.5	6.9	140	86
	15/7/2002	13:30	3.5	27	6.9	3.5	12.2	7.3	460	150
	27/8/2002	13:30	3.5	28.1	5.2	3	14	7.35	580	158
	29/9/2002	12:30	3.5	28.4	5	2.8	12.4	7.4	600	160
	8/10/2002	13:30	3.5	28	5.2	2.7	14.4	7.41	650	168
	17/11/2002	14:00	3.5	26.6	5.8	2.6	12.2	7.35	672	172
	29/12/2002	13:00	3		5.2	2.4	12.5	7.5	710	172
	8/1/2003	12:30	3.5	18	5.4	2.4	10.4	7.4	710	192
	9/2/2003	13:30	3.5	23	5.2	2.2	12	7.6	810	194
Bengal Indigo Balu (River)	22/1/2002	13:00	8.5	22.8	3.3	8		6.98	437	58
	3/2/2002	12:30	8	21.8	3.2	9		6.98	450	66
	4/3/2002	12:30	7.5	27	4	10		6.9		200
	7/4/2002	12:00	9	28	4.2	8		6.9	650	190
	7/5/2002	12:30	8.5	28.5	5	3.5		7.01	650	180
	18/6/2002	12:00	6	28	5	4		6.94	450	180
	7/7/2002	12:00	6.2	27	6.5	3.5		6.85	110	185
	6/8/2002	12:30	10.5	28	6.4	3.4		7.1	100	180
	15/9/2002	11:30	10	28.6	6.2	3.5		7:12	120	188
	20/10/2002	12:00	8	28	6.2	3.4		7.15	140	190
	3/11/2002	12:30	9	27	6.7	3.5		7.16	148	192
	23/12/2002	12:00	8	24	6.6	3		7.2	150	180
Bengal Indigo Balu (Drain)	22/1/2002	13:30	8	22.8	4.8	2.4		7.8	1150	110
	3/2/2002	13:00	4	21.8	4.9	12		7.4	1030	98
	4/3/2002	13:00	4	27	2.4	15		7.68		1000
	7/4/2002	12:30	4	28	4	10		7.65	2400	1020
	7/5/2002	13:00	6	28.5	4.2	8		7.6	2400	1000
	18/6/2002	12:30	4.5	28	3.5	12		7.8	2410	1018

Table A.5 continued

Station/River	Date	Time	Turbidity (NTU)	Temp 0C	DO (mg/l)	BOD5 at 200C (mg/l)	COD (mg/l)	pH	EC (micro S/cm)	Total Alkinity (mg/l)
Bengal Indigo	7/7/2002	12:30	3.5	27	4.4	10	38	7.65	2000	1000
Balu (Drain)	6/8/2002	13:20	3.5	28	4.2	12	48	7.61	2050	1014
	15/9/2002	12:00	3.5	28.5	4.6	10		7.62	2100	1020
	20/10/2002	12:30	3.5	28	4.8	10		7.82	1800	986
	3/11/2002	13:30	3.5	27	6.2	3		7.84	1832	1000
	23/12/2002	12:45	3	24	6	2.8		7.85	1840	1012

Table A.6 Water Quality Data of the Peripheral River System (Source : WSP International, 1998; IWM, 2005)

River/Khal	Location Name	Station ID	Date of Collection	Parameters Tested (mg/l)									Coliform	
				BOD_5	COD	NH_3-N	NH_4-N	NO_3-N	PO_4^{3-}	Cr	Pb	Hg	T.coli	F.coli
Turag	Garanchandbari	Turag-2												
			18-Jan-98	4.8						0				
			16-Feb-98	30.4				0.8	2.1		0.047	2.023		80
			22-Apr-03	1.8	16	0.04	2.11	-		0.0012	0.166	<MDL		
			14-Mar-04	30	50	0.5	18.1	2.9		0.0058	0.017	-		
			03-Apr-04	22	50	0.26	12.64	3	0.97	0.00086	<0.001	-	TNTC	TNTC
Turag	Harirampur	Turag-1												
			18-Jan-98	4.2						0.009				
			16-Feb-98	23.6				0.5	1.59	0.112	0.036	0.381		29
			22-Apr-03	1.8	24	0.04	2.21	-		0.0026	0.137	<MDL		
			08-Dec-03	1.3	2	0.047	1.793	0.8		<0.001	<0.001	-		
			14-Mar-04	29	48	0.44	19.6	2.6		0.01	0.0028	-		
			03-Apr-04	20	52	0.2	12.1	4.1	1.39	0.0021	<0.001	-	TNTC	TNTC
Turag	Mirpur Bridge	Buri-1	17-Dec-97	37						0.032				
			19-Jan-98	3.6						0.033				
			17-Feb-98	26				0.2	2.16		0.084	1.867		44
			23-Apr-03	1.4	29	0.02	1.18	-		0.0034	0.221	<MDL		
			08-Dec-03	1.8	3	0.041	1.459	0.6		<0.001	<0.001	-		
			15-Mar-04	30	52	0.096	6.204	6.6		0.0069	0.0011	-		
			04-Apr-04	18	48	0.16	7.34	5.4	3.94	0.00433	<0.001	-	TNTC	TNTC
Turag	Katashur	Buri-2	17-Dec-97	34						0.029				
			19-Jan-98	3.3						0.029				
			17-Feb-98	18.4				0.1	2.57			0.753		177
			23-Apr-03	1.6	31	0.04	2.31	-		0.0044	0.224	<MDL		
			08-Dec-03	1.4	3	0.061	2.259	0.8		<0.001	<0.001	-		
			15-Mar-04	33	54	0.192	11.56	17.4		0.0049	0.0013	-		
			04-Apr-04	36	63	0.05	1.9	7.8	3.58	0.00486	<0.001	-	TNTC	TNTC
Buriganga	Kamrangir Char	Buri-3	18-Dec-97	38						0.019				
			20-Jan-98	1.8						0.009				
			18-Feb-98	29.2				0.1	1.14			1.566		9
			26-Apr-03	29	39	0.19	7.09	-		0.0067	0.231	<MDL		

Table A.6 continued

River/Khal	Location Name	Station ID	Date of Collection	Parameters Tested (mg/l)									Coliform	
				BOD_5	COD	NH_3-N	NH_4-N	NO_3-N	PO_4^{3-}	Cr	Pb	Hg	T.coli	F.coli
Buriganga	Kamrangir Char	Buri-3	09-Dec-03	2.8	8	0.029	2.671	0.5		0.005	<0.001	-		
			16-Mar-04	56	92	0.36	16.64	0.6		0.0065	-	-		
			05-Apr-04	20	44	10.68	0.07	1.5	0.42	0.27	<0.001	-	TNTC	TNTC
		Buri-4	18-Dec-97	34						0.021				
			20-Jan-98	21.3						0.015				
			18-Feb-98	31.6				0.1	4.45			4.34		910
			26-Apr-03	27	85	0.21	11.29	-		0.0081	0.234	<MDL		
Dhaleswari	Keraniganj	Buri-5	18-Dec-97	33						0.021				
			20-Jan-98	3.9						0.019				
			18-Feb-98	30				0.4	1.53			4.569		157
			27-Apr-03	8	53	0.25	9	-		0.0066	0.111	<MDL		
			09-Dec-03	1.8	3	0.048	4.021	0.7		<0.001	<0.001	-		
			16-Mar-04	35	58	0.28	17.72	0.6		0.0058	-	-		
			05-Apr-04	12	29	8.36	0.04	1.8	0.48	<0.001	<0.001	-	TNTC	TNTC
Dhaleswari	Pagla	Buri-6	19-Dec-97	28						0.027				
			21-Jan-98	15.3						0				
			19-Feb-98	30				0.1	1.7			2.263		41
			26-Apr-03	12	24	0.31	10.84	-		0.0024	0.23	<MDL		
			10-Dec-03	3.2	17	0.017	2.463	0.9		<0.001	<0.001	-		
			17-Mar-04	10	16	0.19	9.21	0.7		0.0041	-	-		
			06-Apr-04	4	10	0.55	0	2.5	0.4	<0.001	<0.001	-	TNTC	TNTC
Dhaleswari	Fatulla	Buri-7	19-Dec-97	27						0.016				
			21-Jan-98	16.2						0.02				
			19-Feb-98	29.2				0.1	1.55			1.075		8
			26-Apr-03	12	18	0.23	7.72	-		0.002	0.095	<MDL		
			10-Dec-03	2.4	4	0.017	1.573	0.8		<0.001	<0.001	-		
			17-Mar-04	8	14	0.08	4.22	3.1		0.00001	-	-		
			06-Apr-04	3	10	0.44	0.01	2.4	0.36	<0.001	<0.001	-	TNTC	TNTC
Buriganga	Hariharpara	Buri-8	19-Dec-97	29						0.009				
			21-Jan-98	14.7						0.012				
			19-Feb-98	31.2				2.1	1.09	0.004	0.034	2.007		3
			27-Apr-03	16.5	29	0.06	3.09	-		<0.001	0.058	<MDL		

Table A.6 continued

River/Khal	Location Name	Station ID	Date of Collection	Parameters Tested (mg/l)									Coliform	
				BOD_5	COD	NH_3-N	NH_4-N	NO_3-N	PO_4^{3-}	Cr	Pb	Hg	T.coli	F.coli
Dhaleswari	Nabinagar	Buri-9	21-Dec-97	27						0.023				
			22-Jan-98	6.9						0				
			21-Feb-98	22				2.4	0.554		0.013	1.777		3
			27-Apr-03	12.5	16	0.04	1.51	-		<0.001	0.049	<MDL		
			10-Dec-03	2.9	4	0.014	0.976	1.2		<0.001	<0.001	-		
			18-Mar-04	2	4	0.01	2.29	2.3		-	-	-		
			10-Apr-04	1	10	0	0.34	2.5	0.3	<0.001	<0.001	-	TNTC	TNTC
Dhaleswari	Kashipur	Buri-10	21-Dec-97	28						nil				
			22-Jan-98	7.8						0.027				
			21-Feb-98	20				2.2	0.509		0.014	0.475		27
			27-Apr-03	9	19	0.02	0.63			<0.001	0.064	<MDL		
			10-Dec-03	4.5	10	0.008	0.602	1.5		<0.001	<0.001	-		
			18-Mar-04	4.5	6	0.03	1.97	2		-	-	-		
			10-Apr-04	1	10	0	0.27	2.1	0.27	<0.001	<0.001	-	TNTC	TNTC
Dhaleswari	Kalagachia	Buri-11	22-Dec-97	6						0.006				
			23-Jan-98	6.6						0.025				
			22-Feb-98	22.4				0.2	0.566	0.002		0.67		20
			27-Apr-03	13	17	0.02	1.08			0.002	0.103	<MDL		
			11-Dec-03	2.1	4	0.011	0.809	1.3		<0.001	<0.001	-		
			20-Mar-04	0.8	2	0.01	0.41	1		0.002	-	-		
			11-Apr-04	2	10	0	0.29	1.8	0.13	0.00019	<0.001	-	TNTC	TNTC
Lakhya	Masinabanda	Lakh-1	22-Dec-97	6						0.01				
			23-Jan-98	6.6						0.022				
			22-Feb-98	28.8				0.6	0.746		0.018	1.657		5
			27-Apr-03	10.8	32	0.05	2.8			0.0018	0.12	<MDL		
			11-Dec-03	5.5	7	0.035	1.875	1.4		<0.001	<0.001	-		
			20-Mar-04	0.7	2	0.01	0.54	0.7		0.001	0.0001	-		
			11-Apr-04	1	10	0	0.26	2.3	0.23	<0.001	<0.001	-	TNTC	TNTC
Lakhya	Pathantali	Lakh-1a	11-Dec-03	3.1	5	0.039	1.991	1.6		<0.001	<0.001			
			21-Mar-04	3	8	0.04	1.96	1.3		<0.001	<0.001	-		
			12-Apr-04	6	13	0.49	0.01	2.2	0.84	<0.001	<0.001	-	TNTC	TNTC

Table A.6 continued

River/Khal	Location Name	Station ID	Date of Collection	Parameters Tested (mg/l)									Coliform	
				BOD_5	COD	NH_3-N	NH_4-N	NO_3-N	PO_4^{3-}	Cr	Pb	Hg	T.coli	F.coli
Lakhya	Siddhirganj	Lakh-2	23-Dec-97	3.5						0.01				
			24-Jan-98	7.2						0.015				
			23-Feb-98	22.8				1.3	0.89	0.011	0.05	2.651		2.96
			30-Apr-03	1.2	22	0.04	2.03			<0.001	0.03	<MDL		
			11-Dec-03	3.5	7	0.041	0.949	2		<0.001	<0.001	-		
			21-Mar-04	1	2	0.01	0.94	1.6		-	-	-		
			12-Apr-04	6	8	7.79	0.06	1.3	4.56	<0.001	<0.001	-	TNTC	TNTC
Lakhya	Sarulia	Lakh-2a	11-Dec-03	5	9	0.031	2	3.1		<0.001	<0.001	-		
			24-Mar-04	19	44	0	6	1.1		0.0024	0.0019			
			15-Apr-04	10	17	3.33	0.02	2	2.33	<0.001	<0.001	-	TNTC	TNTC
Lakhya	Demra	Lakh-3	23-Dec-97	3.5						0.01				
			24-Jan-98	6.3						0.009				
			23-Feb-98	23.2				1.4	0.928	0.007	0.03	2.996		2.57
			29-Apr-03	6.8	17	0.04	1.55			0.0038	0.039	<MDL		
			11-Dec-03	4	8	0.04	1.83	2.5		<0.001	<0.001	-		
			24-Mar-04	1.8	4	0.01	0.84	1.7		0.00619	0.00273	-		
			15-Apr-04	5	7	3.05	0.05	1.9	2.18	<0.001	<0.001	-	TNTC	TNTC
Lakhya	Gandharbapur	Lakh-4	24-Dec-97	2						0.012				
			25-Jan-98	9						0.037				
			24-Feb-98	24				1.1	1.025		0.018	0.611		5.2
			29-Apr-03	2.4	8	0.04	0.6			<0.001	0.05	<MDL		
			12-Dec-03	6	9	0.03	1.71	3.1		<0.001	<0.001	-		
			22-Mar-04	3.5	8	0.02	1.98	3.1		0.00029	0.00504	-		
			13-Apr-04		4	0.49	0.01	2.5	1.78	<0.001	<0.001	-	TNTC	TNTC
Lakhya	Rupganj	Lakh-5	24-Dec-97	3						0.016				
			25-Jan-98	9.3						0.028				
			24-Feb-98	24.8				2.2	0.387	0.007	0.018	2.011		0.6
			29-Apr-03	1.8	6	0.04	0.25			<0.001	0.067	<MDL		
			10-Dec-03	1.4	4	0.001	0.289	0.6		<0.001	<0.001	-		
			22-Mar-04	7	18	0.03	2.77	2.9		0.00114	0.00057	-		
			13-Apr-04	6	11	0.25	0	2.4	1.52	<0.001	<0.001	-	TNTC	TNTC

Table A.6 continued

River/Khal	Location Name	Station ID	Date of Collection	Parameters Tested (mg/l)									Coliform	
				BOD_5	COD	NH_3-N	NH_4-N	NO_3-N	PO_4^{3-}	Cr	Pb	Hg	T.coli	E.coli
Balu	Keodala	Balu-1	25-Dec-97	8.5						0.032				
			26-Jan-98	7.5						0.018				
			25-Feb-98	72				1.6	1.16	0.13	0.01	0.342		8.5
			29-Apr-03	5.7	18	0.04	1.63			0.0016	0.032	<MDL		
			12-Dec-03	5.5	9	0.064	4.436	1.75		0.001	<0.001	-		
			23-Mar-04	6	15	0.04	2.86	1.8		0.00328	<0.001	-		
			14-Apr-04	12	37	8.6	0.1	1.9	3.6	<0.001	<0.001	-	TNTC	TNTC
Balu	Balurpar	Balu-2	25-Dec-97	7.5										
			26-Jan-98	27.6						0.003				
			25-Feb-98	670				0.6	8.76	0.036	0.038	2.932		203
			29-Apr-03	8	57	0.16	12.34			<0.001	0.026	<MDL		
			11-Dec-03	14.4	43	0.101	9.649	3.5		0.0012	<0.001	-		
			23-Mar-04	4	13	0.04	3.01	2.6		0.00176	0.00071	-		
			14-Apr-04	20	45	10.51	0.09	1.5	3.94	<0.001	<0.001	-	TNTC	TNTC
Tongi khal	Tongi		30-Apr-03	8	103	0.2	12.8	-		0.0018	0.05	<MDL		
Karnatoli Khal	Karnatoli brdg.		30/Apr/03	2.4	15	0.05	0.83	-		0.0011	0.043	<MDL		

Note: All parameters are in mg/l except pH and Coliform

Coliforms in 1000/ 100 ml of water

BOD_5 at 20 ^{0}C

COD in $K_2Cr_2O_7$ value

"MDL" represents minimum detection limit

"-" indicates measurement is not available

Table A.7 : Wastewater Quality Data in the Wastewater Outlets located in the periphery of Dhaka and Narayanganj city(Source: WSP International 1998, IWM, 2005)

Station	Date of Collection	Flow (m^3/s)	Parameters Tested (mg/l)										Coli (1000/100 ml)		Q (m^3/s)
			BOD	COD	NH_3-N	NH_4-N	NO_3-N	PO_4	Cr	Pb	Hg	Zn	T.coli	F.coli	
S3	January-98		11									1.102	3.8	3.1	
	February-98		95						0.015			2.399	0.56	0.42	
	February-98		155		4.42			0.37	0.016	0.022		0.163		10.8	
S4	January-98		27						0.017	0.057		0.21	102	82	
	February-98		90		10.53			1.89	0.014	0.066		2.392	640	520	
	February-98		42.5						0.022	0.016		2.986		1200	
	March-04	0.3	54	89	0.605	26.395	1.7		0.218	0.022	-				3
S5	January-98		51						0.013	0.049		0.265	987	836	
	February-98		240		27.63			7.15	0.024	0.057		0.521	54000	32000	
	February-98		230						0.027	0.068		3.555		9200	
	March-04	0.1	52	86	0.325	40.93	0.8		0.185	0.107	-				0.1
	April-04	0.1	30	69	0.26	15.24	1.7	5.15	0.00083	<0.001	-		TNTC	TNTC	0.1
S6	January-98		52						0.017	0.016		0.23	667	525	
	February-98		390		33.43			8.01	0.018	0.058		0.621	3920	3000	
	February-98		85						0.031	0.114		4.941		2000	
	March-04	1.4	175	291	0.121	26.38	1.6		0.0045	0.0048	-				1.4
	April-04	1.4	45	138	0.286	22.214	2.1	9.4	0.00043	<0.001	-		TNTC	TNTC	1.4
S7	December-97		400						10.08						
	January-98		580						31.083						
	February-98		420		98.9			8.82	17.24	0.151		2.654		3200	
	April-03	1.3	460	886	1.19	59.81	-		1.49	0.143	<MDL				3
	December-03	0.385	1450	2402	25.6	111.9	2.5		22.42	4.83	-				0.385
	March-04	0.64	1280	2130	1.875	56.63	5.8		7.28	0.0056	-				1.64
	April-04	0.82	425	2134	1.396	84.104	8.9	6.25	1.746	<0.001	-		TNTC	TNTC	0.82
S8	December-97		110						0.058						
	January-98		155						0.125						
	February-98		580		40.88			13.3	0.27	0.111		2.161		17600	
	April-03	0.45	28	154	0.46	37.29	-		0.042	0.131	<MDL				1.5
	December-03	0.36	123	240	0.37	52.4	1		0.17	<0.001	-				0.36
	March-04	0.1	1425	2374	2.48	71.52	2.8		26.45	0.01	-				0.42
	April-04	0.3	60	205	0.289	20.96	1.2	1.55	0.048	<0.001	-		TNTC	TNTC	0.3

Table A.7 continued

Station	Date of Collection		Parameters Tested (mg/l)										Coli (1000/100 ml)		Q
			BOD	COD	NH_3-N	NH_4-N	NO_3-N	PO_4	Cr	Pb	Hg	Zn	T.coli	F.coli	(m^3/s)
S9	January-98		305						0.039						
	February-98		240		50.45			12.79	0.029	0.129		2.46		24800	
	April-03	1	130	419	0.04	14.96	-		0.038	0.146	<MDL				1
	December-03	0.5	170	380	0.28	42.8	1.7		0.075	<0.001	-				1.51
	March-04	0.6	625	1042	0.055	15.95	0.3		0.085	0.112	-				0.6
	April-04	0.32	150	585	0.157	27.343	5	9.45	0.014	<0.001	-		TNTC	TNTC	0.32
S10	January-98		510						0.119						
	February-98		520		43.23			14.94	0.091	0.144		4.489		20000	
	April-03	1	125	535	0.05	19.2	-		0.034	0.146	<MDL				1
	December-03	0.67	480	825	0.24	54.5	2.2		0.082	<0.001	-				0.67
	March-04	0.22	450	739	0.05	17.95	1.5		0.033	0.027	-				0.22
	April-04	1.2	140	565	0.085	25.66	5.7	7.65	0.01128	<0.001	-		TNTC	TNTC	1.2
S11	December-03	0.8	68	139	0.17	38.3	0.8		0.057	<0.001	-				0.8
	March-04	0.1	115	188	0.226	45.02	1		0.0047	0.012	-				0.1
Dholai khal	December-97		280						nil						
	January-98		210						0.117						
	February-98		480		50.18			16.62	0.066	0.14		0.14		20000	
	April-03	5	65	425	0.1	31.9			0.022	0.142	<MDL				5
	December-03	4	420	735	0.19	42.6	1.2		0.4	<0.001	-				4.2
	March-04	3.1	125	510	0.13	37.12	0.9		0.0048	no trace					3.1
	April-04	4	380	652	0.04	10.91	5.4	2.07	0.016	<0.001	-		TNTC	<0.002	8
Norai Khal	January-98		40						0.018	0.068		0.072	3200	2000	
	February-98		140						0.014	0.07		1.802	2400	800	
	February-98		270		27.54			8.04	0.043	0.06		1.964		74	
	April-03	7.29	27.5	126	0.14	13.11	-		0.0015	0.114	<MDL				7.29
	February-04	5.93	60	116	0.43	39.64	1.5		0.02	<0.001	-				
	March-04	15.16	32	100	0.11	14.89	1.4		0.00371	0.00124	-				
	April-04	16.32	30	88	18.84	0.16	9.5	6.85	<0.001	<0.001	-		TNTC	TNTC	
B.K. Road khal	December-97		110												
	January-98		35						0.016						
	February-98		110		64.76			25.95	0.021	0.076		1.226		960	
	February-04	0.2	150	178	0.66	83.13	0.4		0.004	0.002	-				0.2
	March-04	0.15	50	154	0.62	70.88	0.2		no trace	no trace	-				0.15
	April-04	0.2	450	756	0.21	23.54	2.9	6.75	0.002	<0.001	-		TNTC	TNTC	0.2

Table A.7 continued

Station	Date of		Parameters Tested (mg/l)										Coli (1000/100 ml)		Q
	Collection		BOD	COD	NH_3-N	NH_4-N	NO_3-N	PO_4	Cr	Pb	Hg	Zn	T.coli	F.coli	(m^3/s)
Tan Bazar khal	December-97		356												
	January-98		430						0.039						
	February-98		460		82.25			23.21	0.023	0.073		1.027		44000	
	February-04	0.25	235	861	0.258	67.74	2075		0.005	0.003	-				0.25
	March-04	0.05	160	652	0.16	68.84	6.2		0.00058	no trace	-				0.05
Kali Bazar khal	December-97		278						0.021						
	January-98		212						0.03						
	February-98		270		56.55			16.99	0.021	0.049		2.16		8800	
	February-04	0.3	225	540	0.343	59.52	2.9		0.005	0.005	-				0.5
	March-04	0.3	130	424	0.15	43.6	4.1		0						0.3
	April-04	0.2	490	850	0.06	17.94	2.8	5	0.001	0.001	-		TNTC	TNTC	0.5
Killarpul khal	December-97		112												
	January-98		72.5						0.027						
	February-98		250		27.6			10.05	0.007	0.076		3.105		2560	
	February-04	0.35	285	342	192	35.02	0		0.004	0.183	-				0.35
	March-04	0.2	140	428	0.1	29.9	1.6		0.0023	<0.001	-				0.2
	April-04	0.21	370	512	0.07	22.18	4.4	7.8	0.003	<0.001	-		TNTC	TNTC	0.21
Majheepara khal	December-97		200						0.052						
	January-98		180						0.031						
	February-98		520		14.85			3.88	0.011	0.113		3.411		40	
	February-04	0.45	280	435	1.826	0.8	3.9		0.023	0.003	-				0.45
	March-04	0.3	120	349	9.25	15	3.3		0.0039	<0.001	-				0.3
	April-04	0.35	190	326	8.68	14.07	4.9	1.39	0.004	<0.001	-		3200	56000	0.35
DND khal	January-98		105						0.052						
	February-98		80						0.03	0.039					
	February-98		58		2.73			1.05	0.025	0.02		3.55		53	
	February-04	0	155	178	2.68	25.01	2		0.011	<0.001	-				0
Kashipur khal	March-98		210												
	March-98		360												
	March-98		225		6.25			3.92	0	0.227		0.339		240	
	February-04	2.625	230	262	2.19	17.84	0.9		0.004	<0.001	-				2.625
	March-04	3.1	35	104	0.31	23.94	0.2		0.018	no trace	-				3.1
	April-04	3	500	844	0.12	9.08	2.7	2.38	<0.001	<0.001	-		TNTC	TNTC	8

APPENDIX-B

Figures of Dissolved Oxygen in Stream

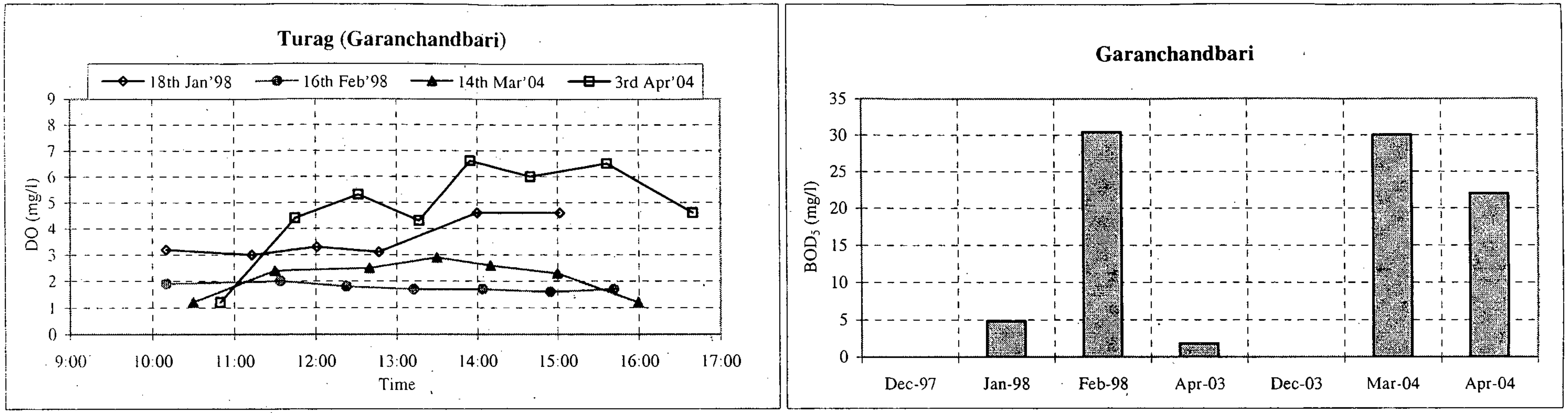


Figure B.1.1 : Diurnal Variation of DO and BOD Concentration of Corresponding Day at Garanchandbari on the Turag River
(Source: Kamal, 1996; WSP International, 1998; IWM, 2005)

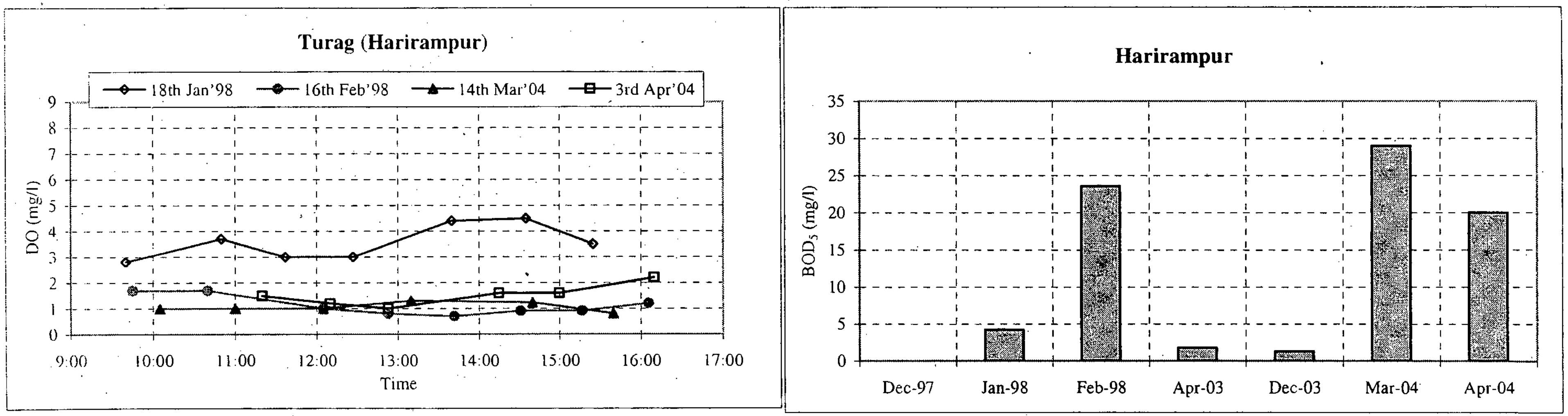
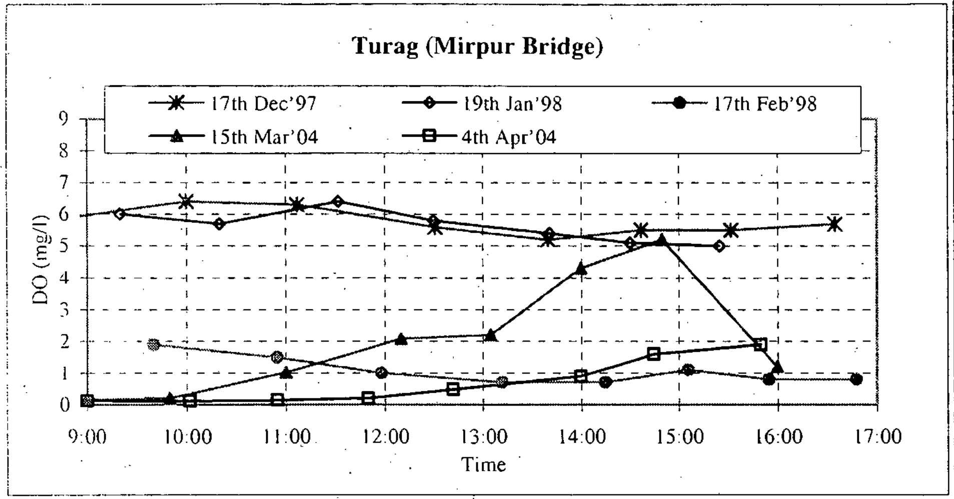


Figure B.1.2 : Diurnal Variation of DO and BOD Concentration of Corresponding Day at Harirampur on the Turag River
(Source: Kamal, 1996; WSP International, 1998; IWM, 2005)



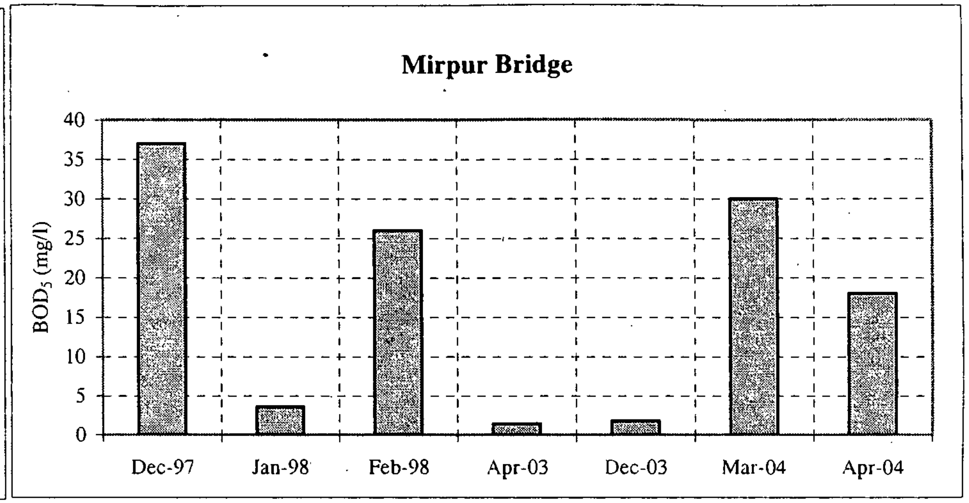
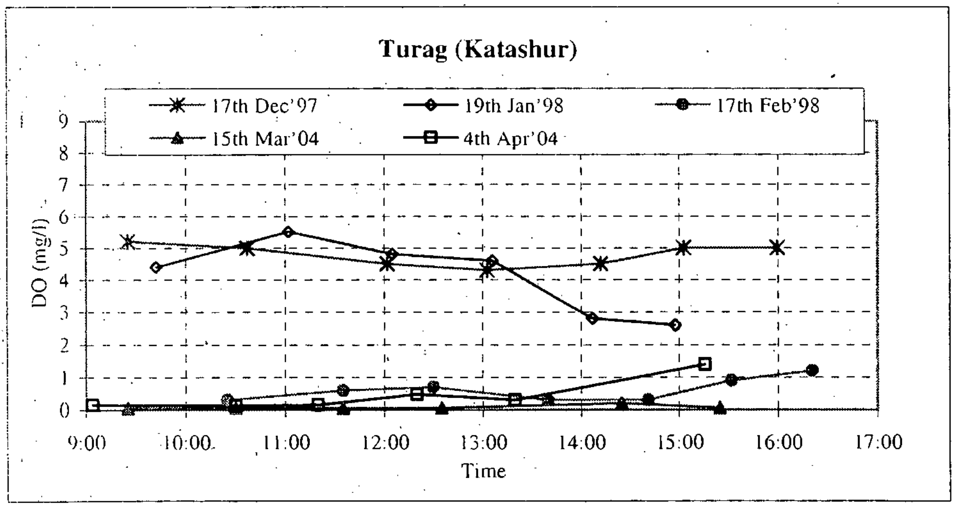


Figure B.1.3 : Diurnal Variation of DO and BOD Concentration of Corresponding Day at Mirpur Bridge on the Turag River
(Source: Kamal, 1996; WSP International, 1998; IWM, 2005)



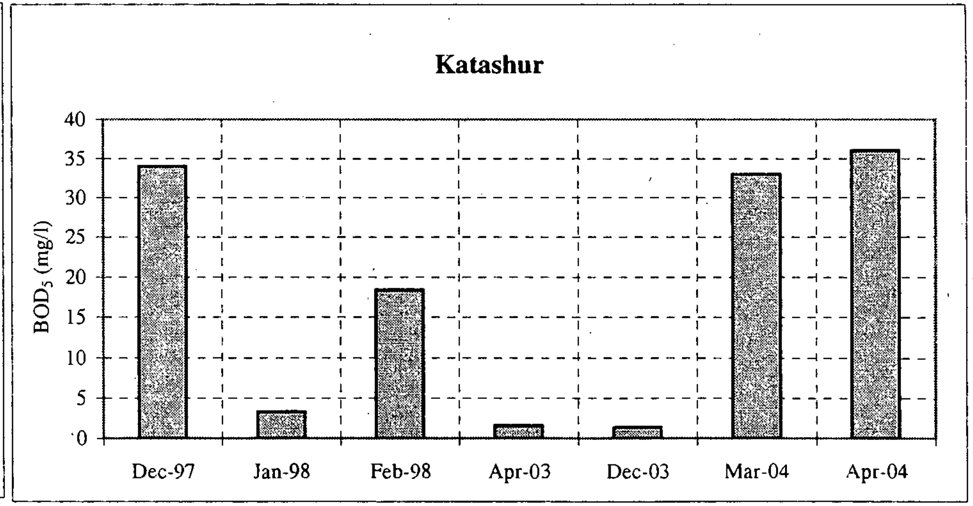
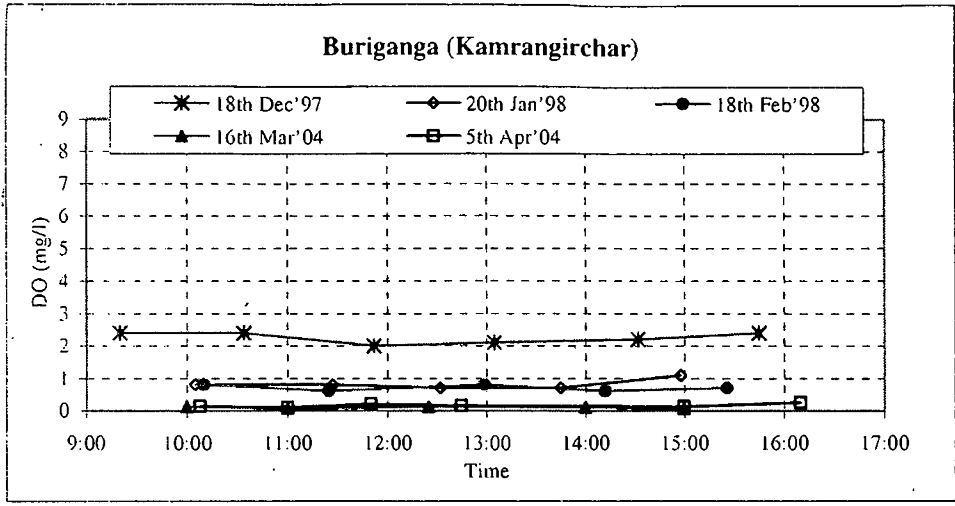


Figure B.1.4 : Diurnal Variation of DO and BOD Concentration of Corresponding Day at Katashur on the Turag River
(Source: Kamal, 1996; WSP International, 1998; IWM, 2005)



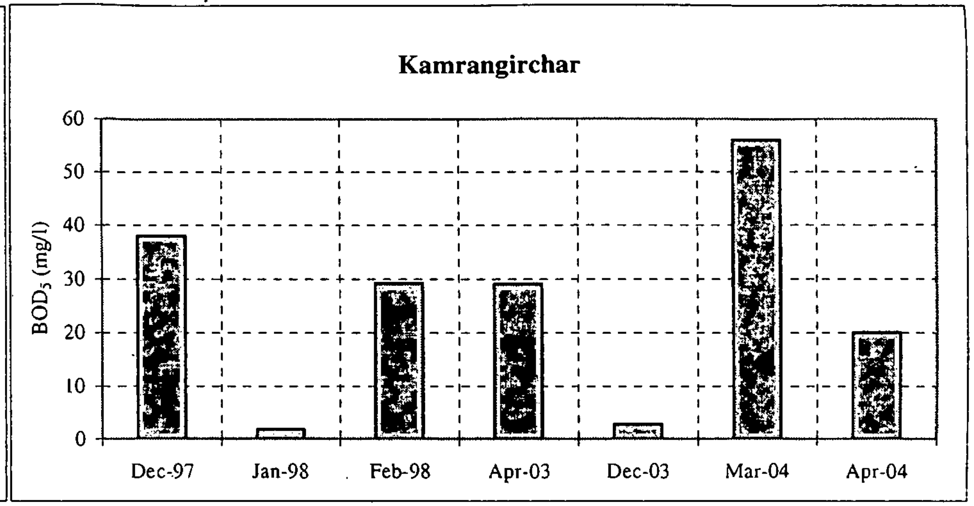
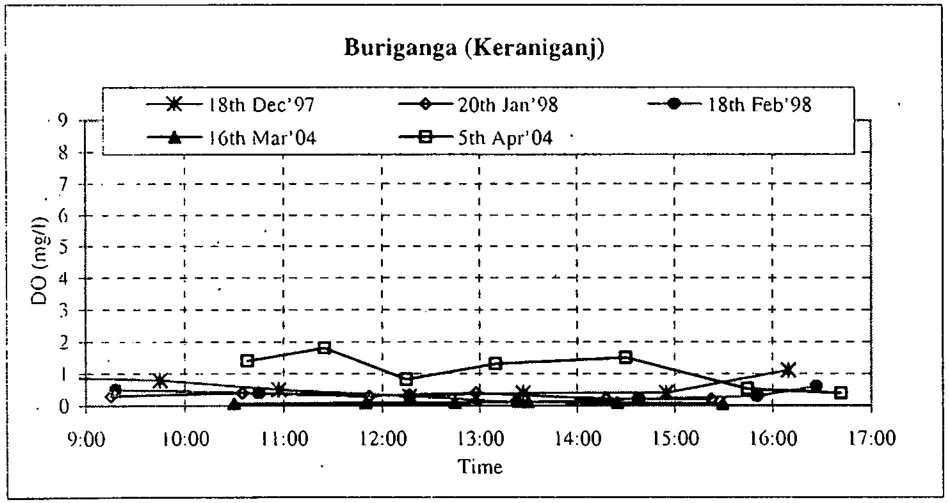


Figure B.1.5 : Diurnal Variation of DO and BOD Concentration of Corresponding Day at Kamrangir Char on the Buriganga River
(Source: Kamal, 1996; WSP International, 1998; IWM, 2005)



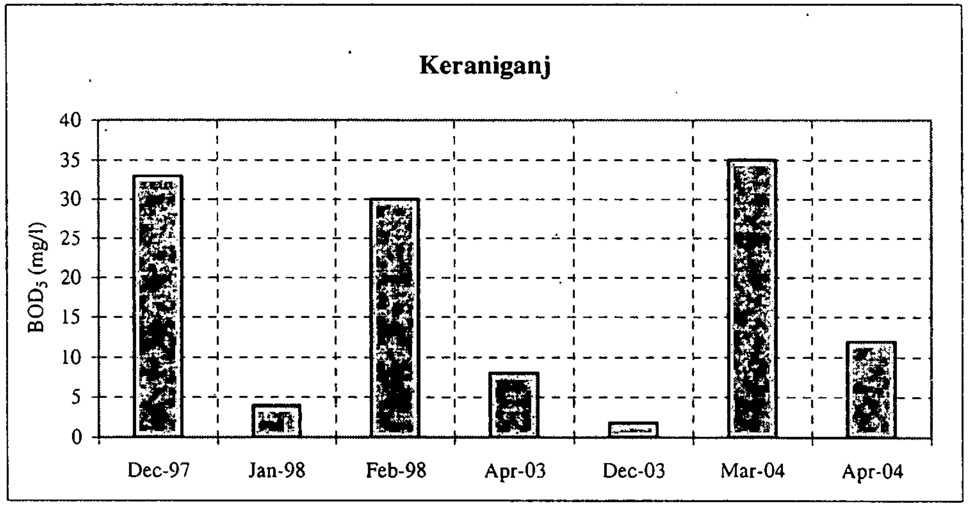


Figure B.1.6 : Diurnal Variation of DO and BOD Concentration of Corresponding Day at Keraniganj on the Buriganga River
(Source: Kamal, 1996; WSP International, 1998; IWM, 2005)

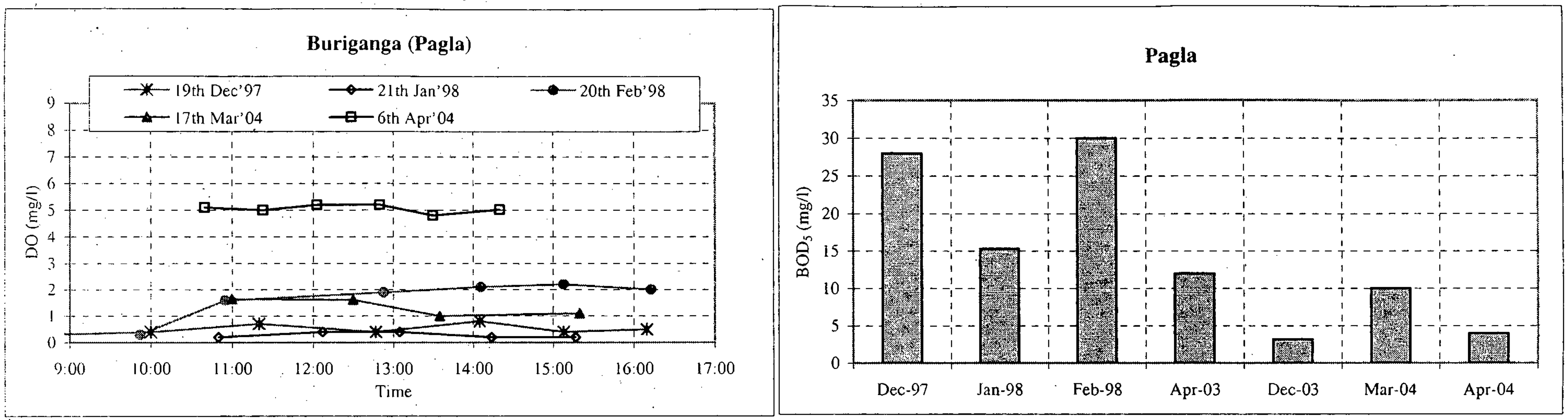


Figure B.1.7 : Diurnal Variation of DO and BOD Concentration of Corresponding Day at Pagla on the Buriganga River
(Source: Kamal, 1996; WSP International, 1998; IWM, 2005)

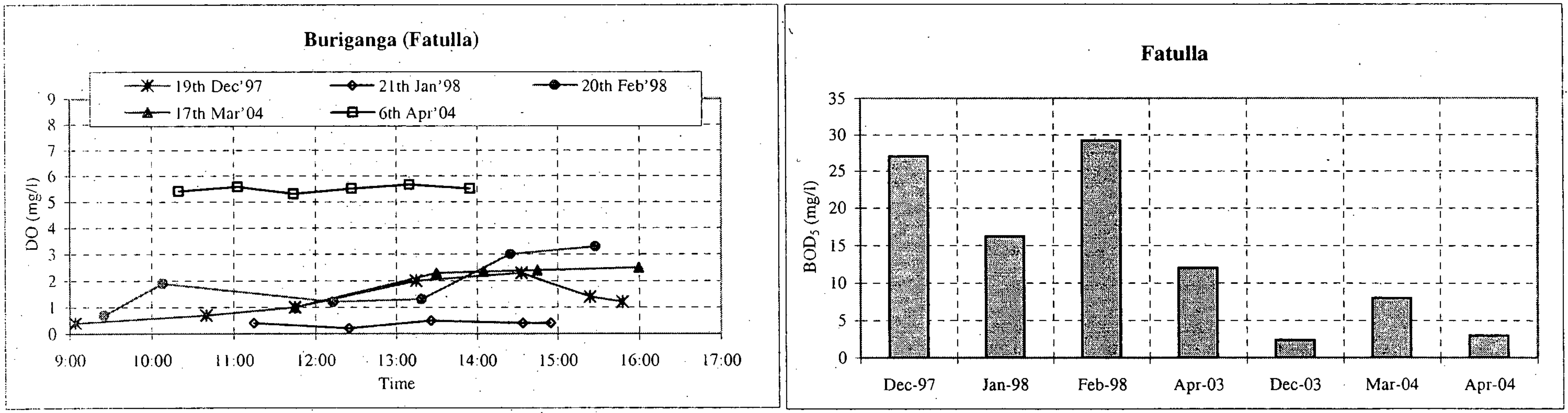


Figure B.1.8 : Diurnal Variation of DO and BOD Concentration of Corresponding Day at Fatulla on the Buriganga River
(Source: Kamal, 1996; WSP International, 1998; IWM, 2005)

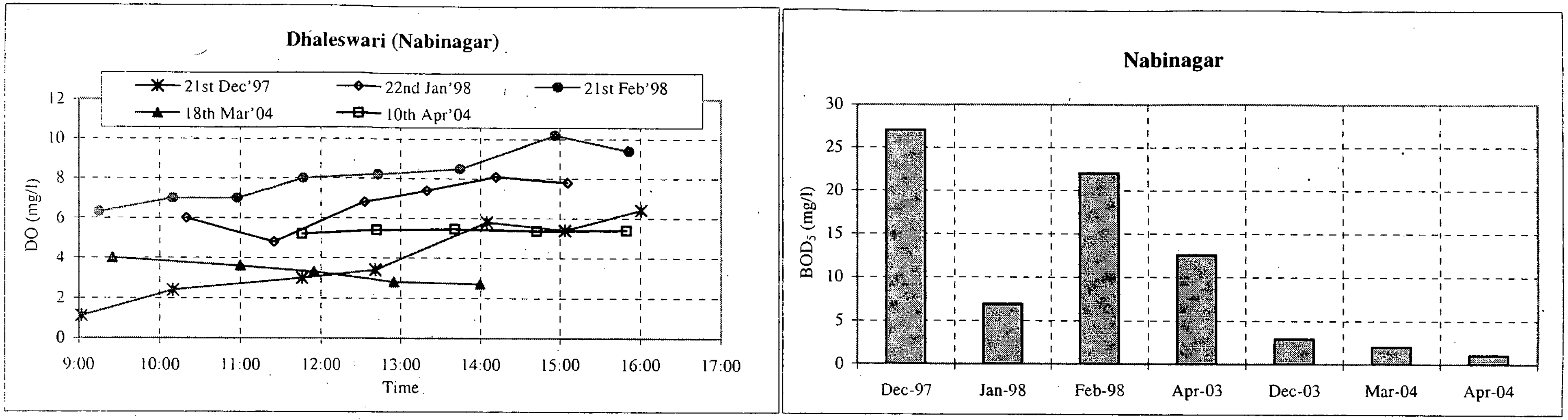


Figure B.1.9 : Diurnal Variation of DO and BOD Concentration of Corresponding Day at Nabinagar on the Dhaleshari River
(Source: Kamal, 1996; WSP International, 1998; IWM, 2005)

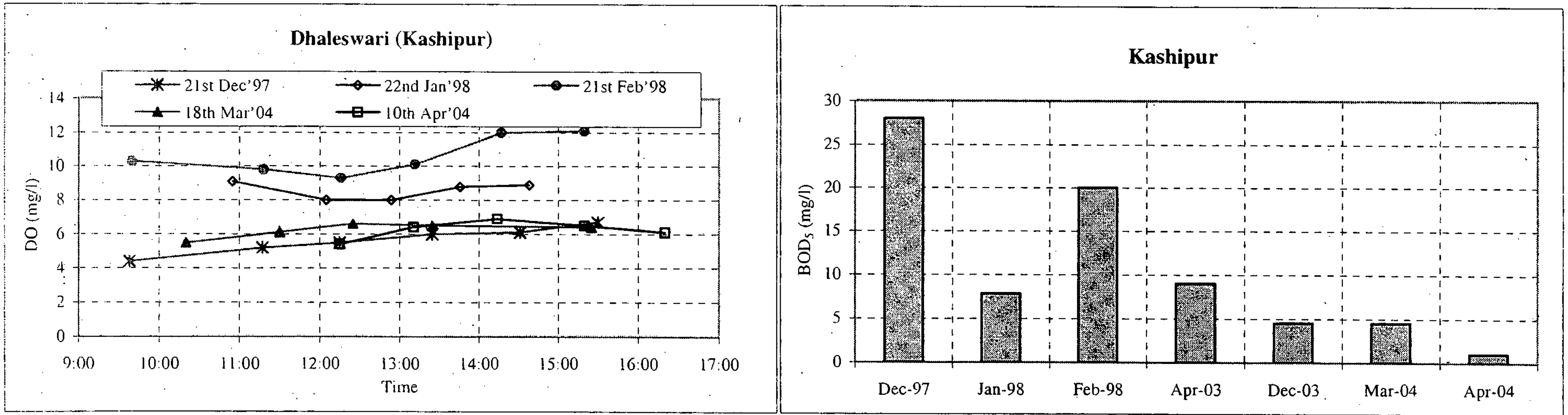


Figure B.1.10 : Diurnal Variation of DO and BOD Concentration of Corresponding Day at Kashipur on the Dhaleshari River
(Source: Kamal, 1996; WSP International, 1998; IWM, 2005)

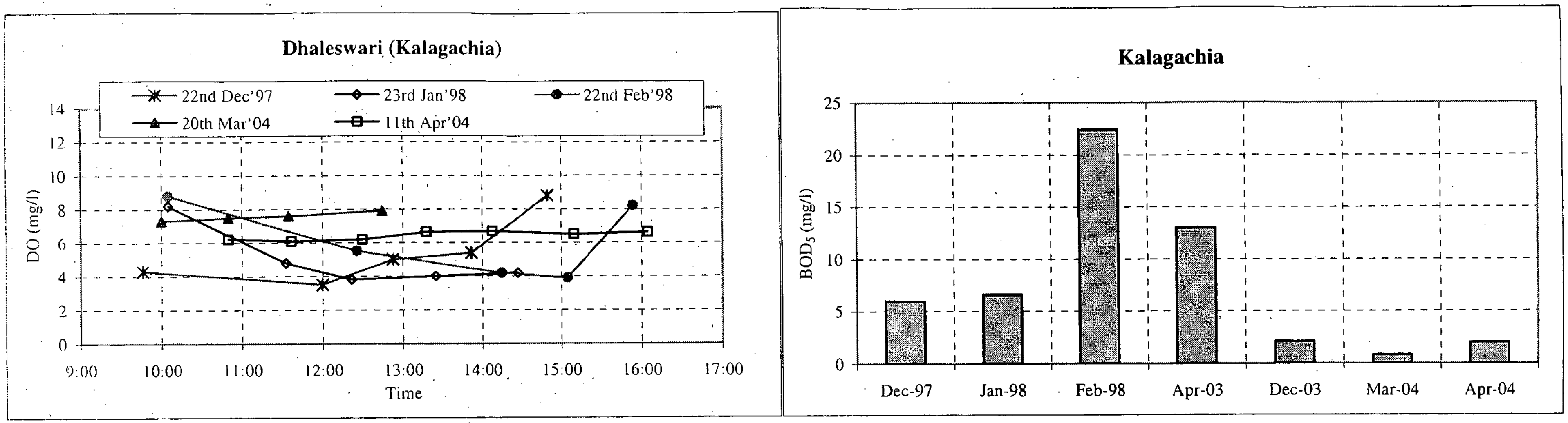


Figure B.1.11 : Diurnal Variation of DO and BOD Concentration of Corresponding Day at Kalagachia on the Dhaleshari River
(Source: Kamal, 1996; WSP International, 1998; IWM, 2005)

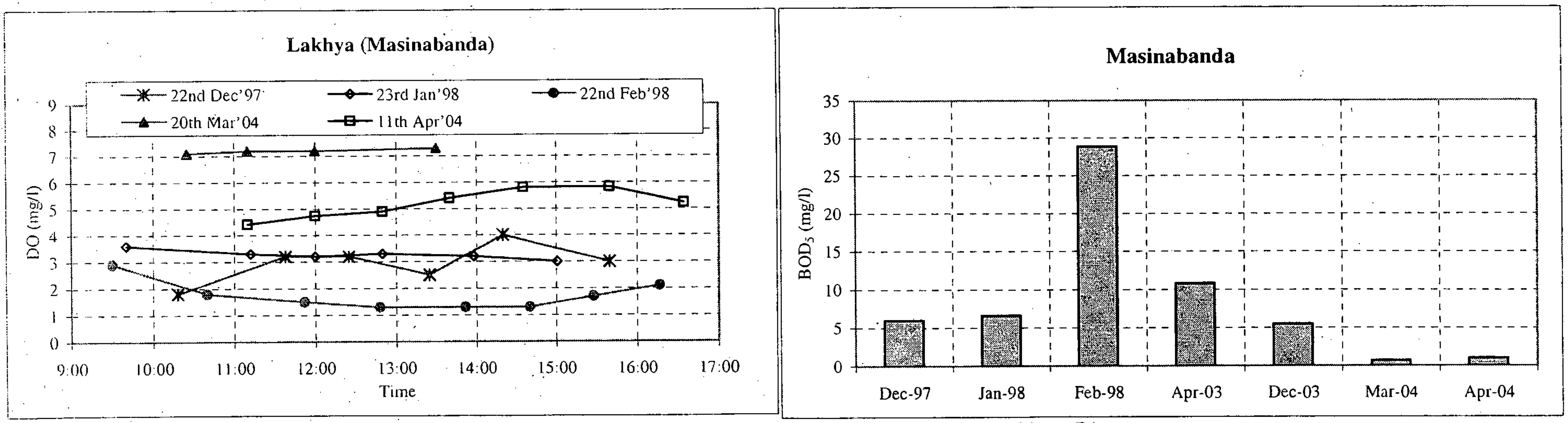


Figure B.1.12 : Diurnal Variation of DO and BOD Concentration of Corresponding Day at Mosinabanda on the Lakhaya River
(Source: Kamal, 1996; WSP International, 1998; IWM, 2005)

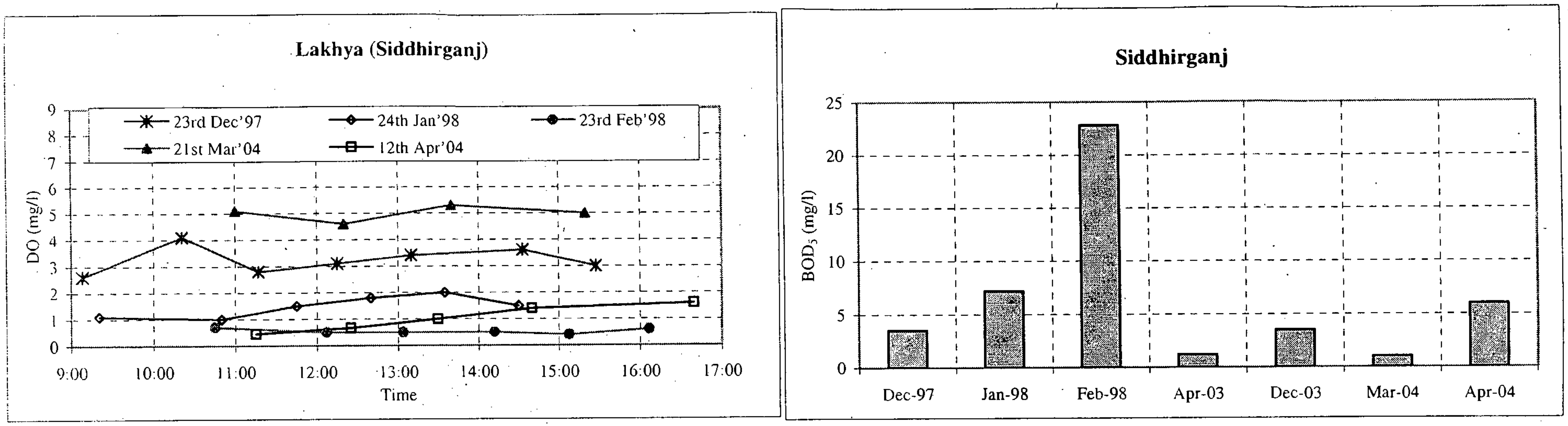


Figure B.1.13 : Diurnal Variation of DO and BOD Concentration of Corresponding Day at Siddhirganj on the Lakhaya River
(Source: Kamal, 1996; WSP International, 1998; IWM, 2005)

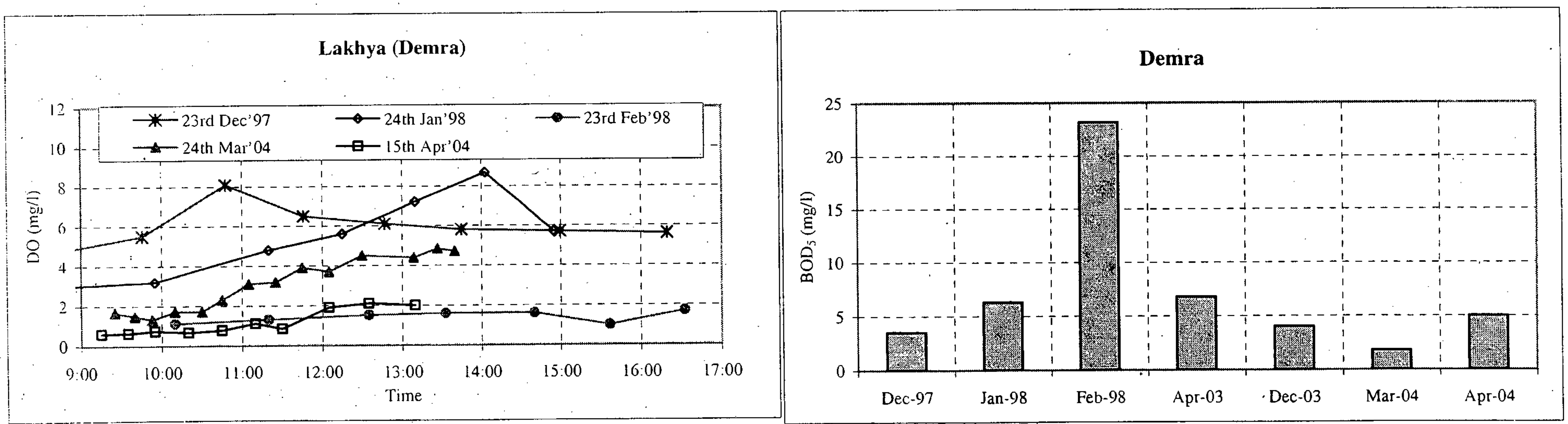


Figure B.1.14 : Diurnal Variation of DO and BOD Concentration of Corresponding Day at Demra on the Lakhaya River
(Source: Kamal, 1996; WSP International, 1998; IWM, 2005)

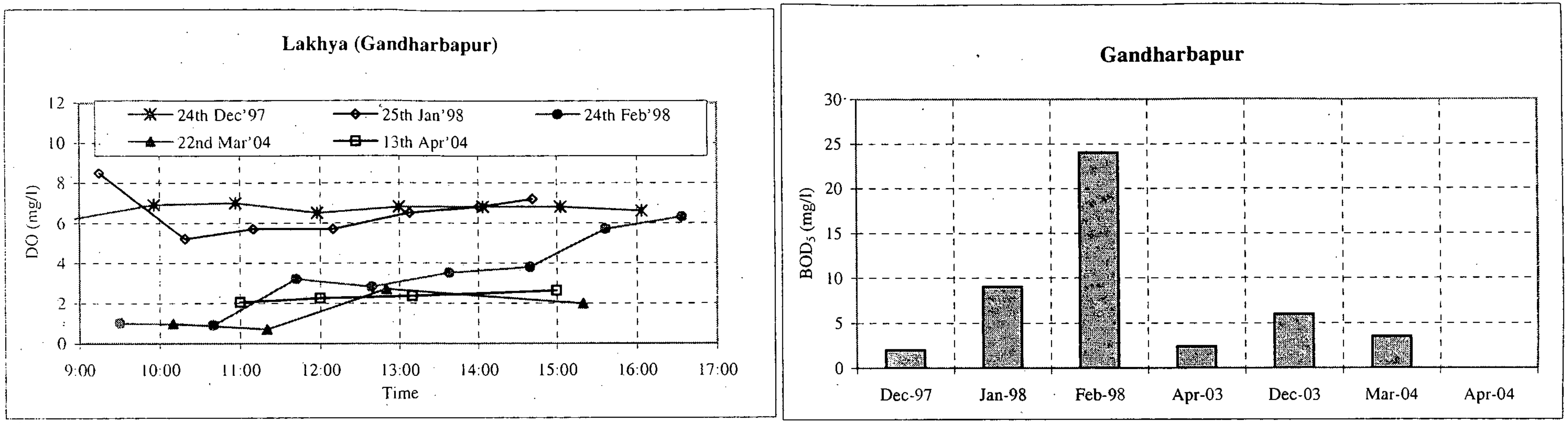


Figure B.1.15 : Diurnal Variation of DO and BOD Concentration of Corresponding Day at Gandharbapur on the Lakhaya River
(Source: Kamal, 1996; WSP International, 1998; IWM, 2005)

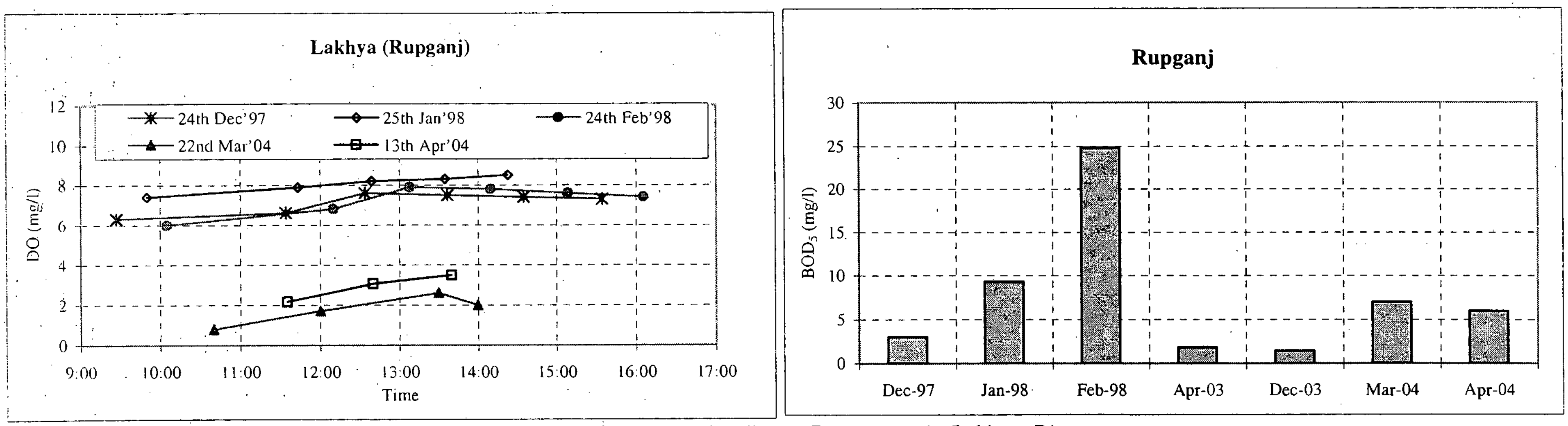
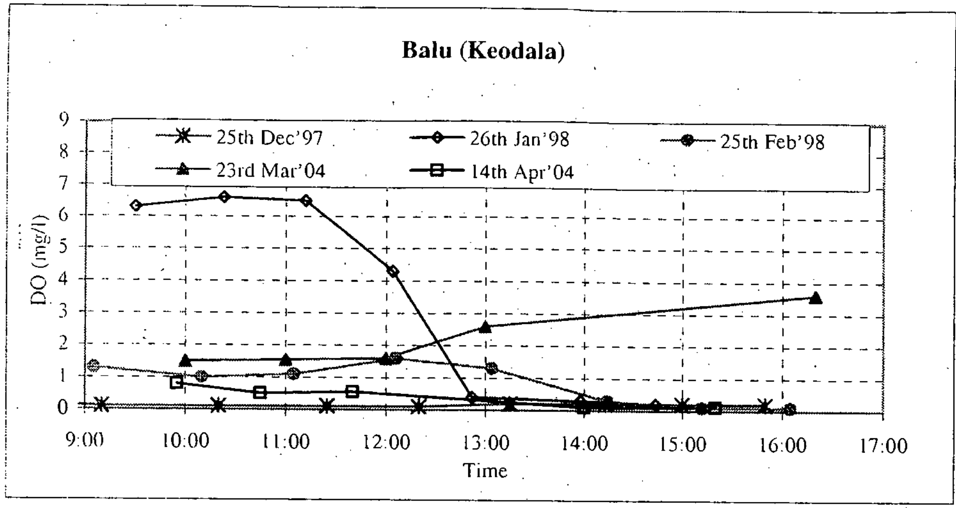


Figure B.1.16 : Diurnal Variation of DO and BOD Concentration of Corresponding Day at Rupganj on the Lakhaya River
(Source: Kamal, 1996; WSP International, 1998; IWM, 2005)



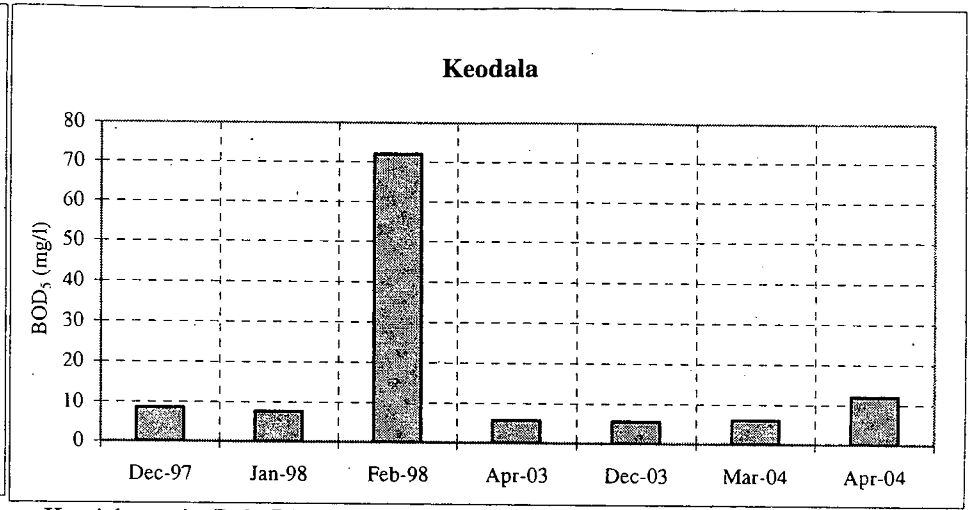
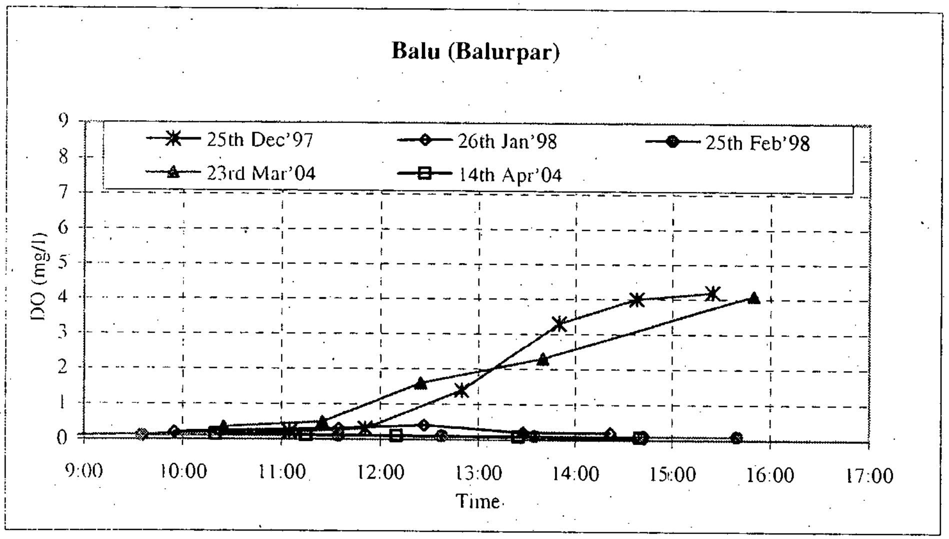


Figure B.1.17 : Diurnal Variation of DO and BOD Concentration of Corresponding Day at Keodala on the Balu River
(Source: Kamal, 1996; WSP International, 1998; IWM, 2005)



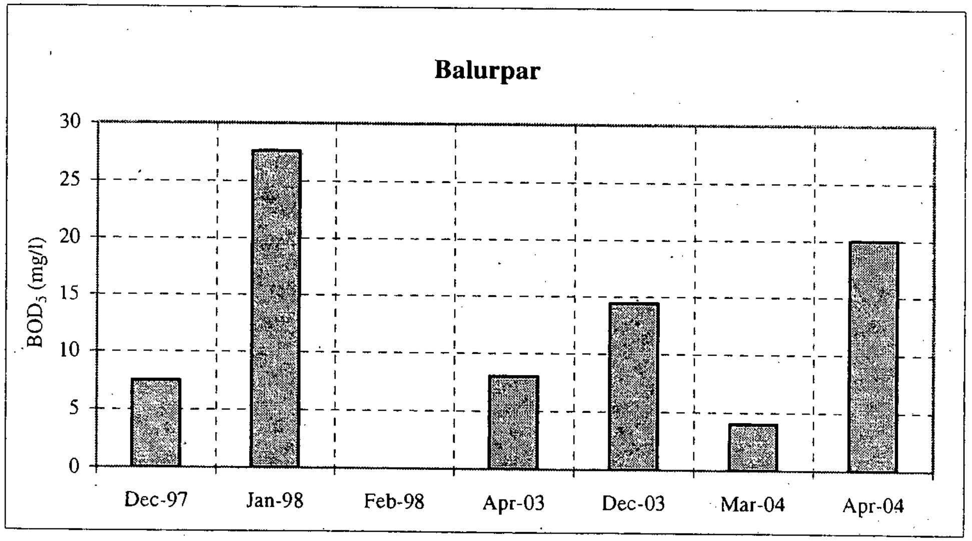


Figure B.1.18 : Diurnal Variation of DO and BOD Concentration of Corresponding Day at Balurpar on the Balu River
(Source: Kamal, 1996; WSP International, 1998; IWM, 2005)

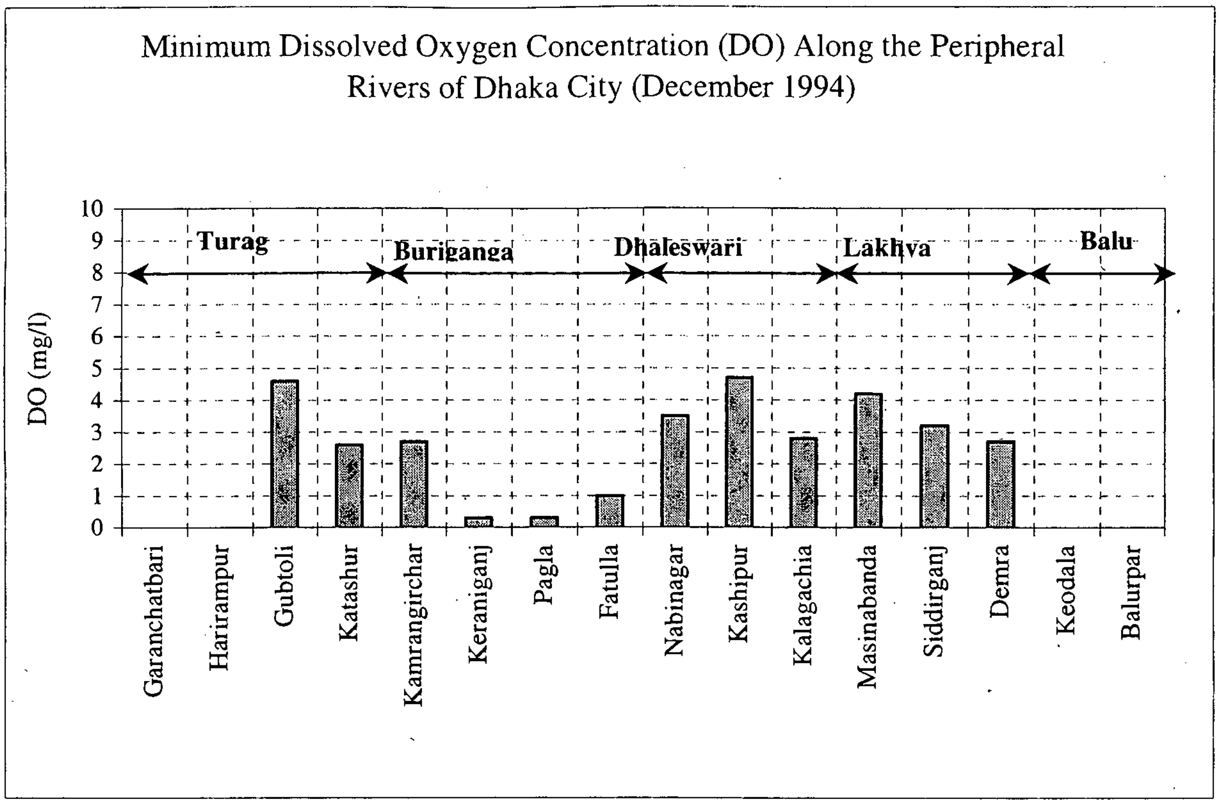


Figure B.2.1 : Minimum DO Concentration in the Peripheral Rivers, December-1994
(Source: Kamal, 1996)

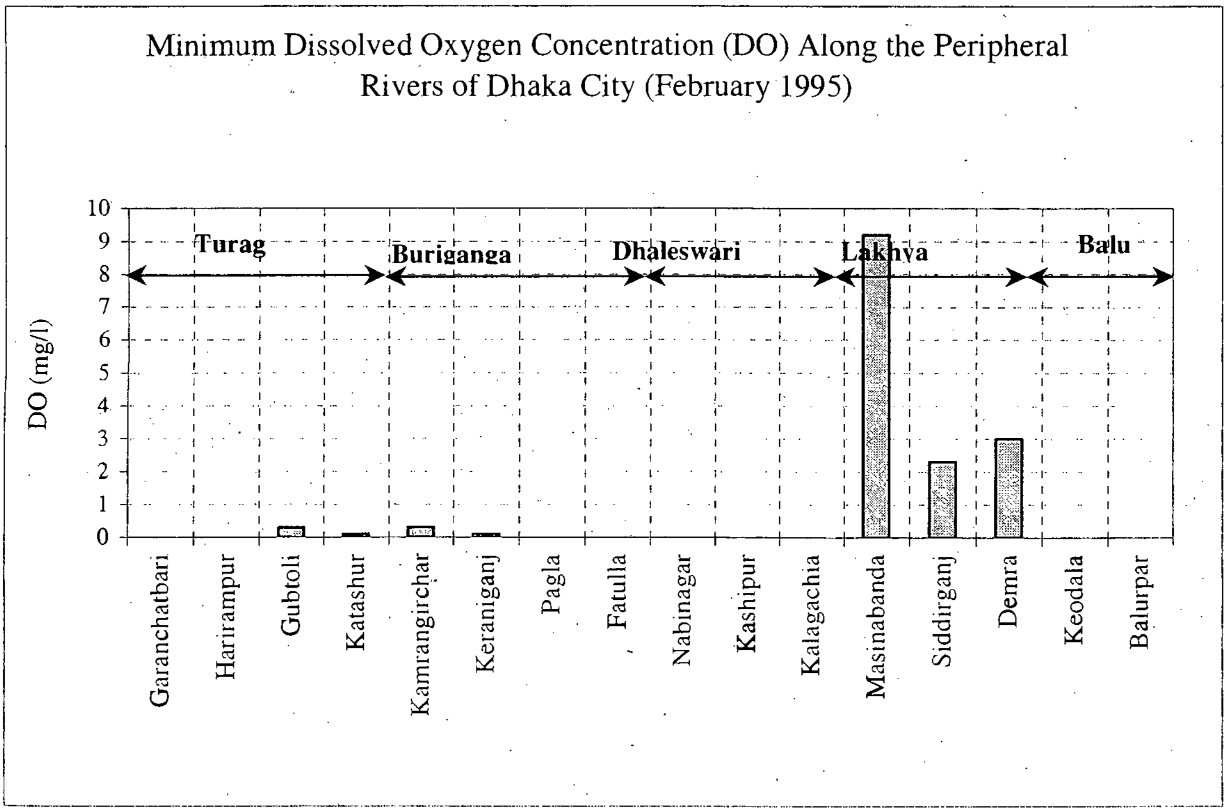


Figure B.2.2 : Minimum DO Concentration in the Peripheral Rivers , February-1995
(Source: Kamal, 1996)

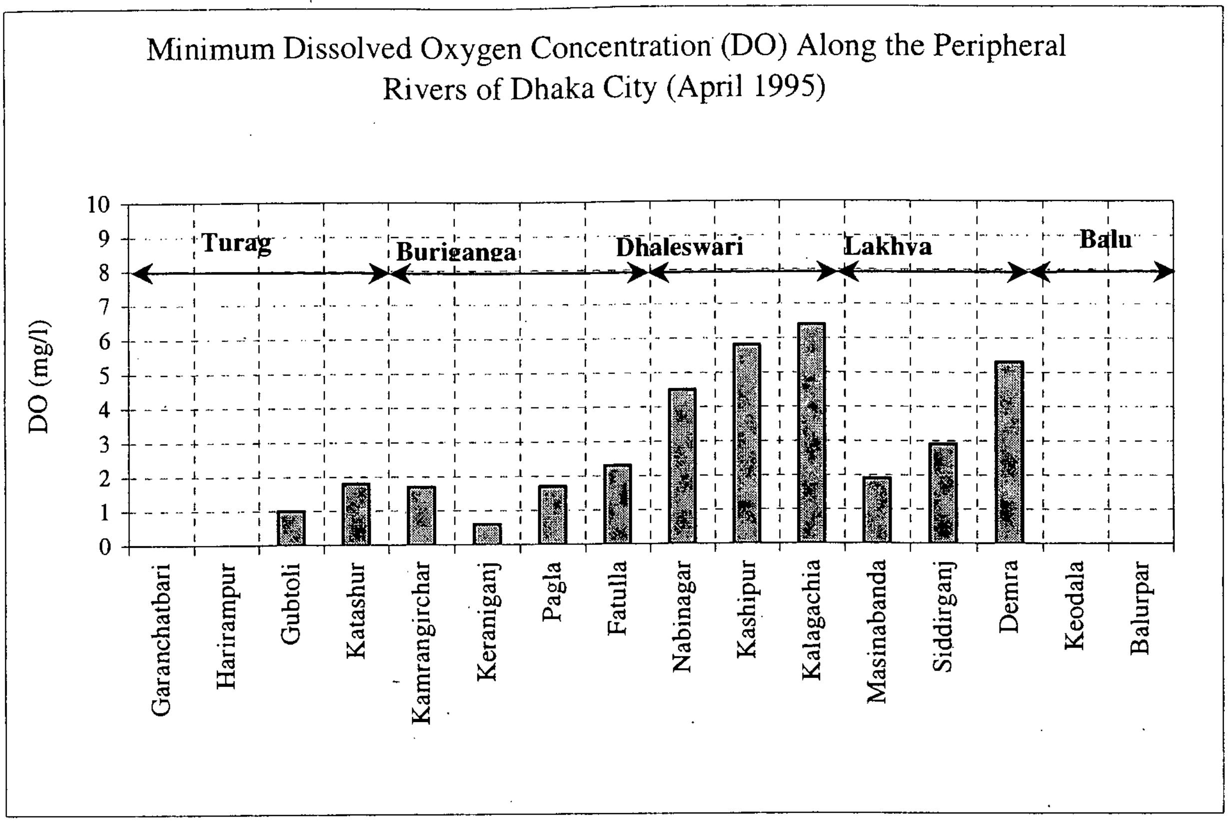


Figure B.2.3 : Minimum DO Concentration in the Peripheral Rivers , April-1995
(Source: Kamal, 1996)

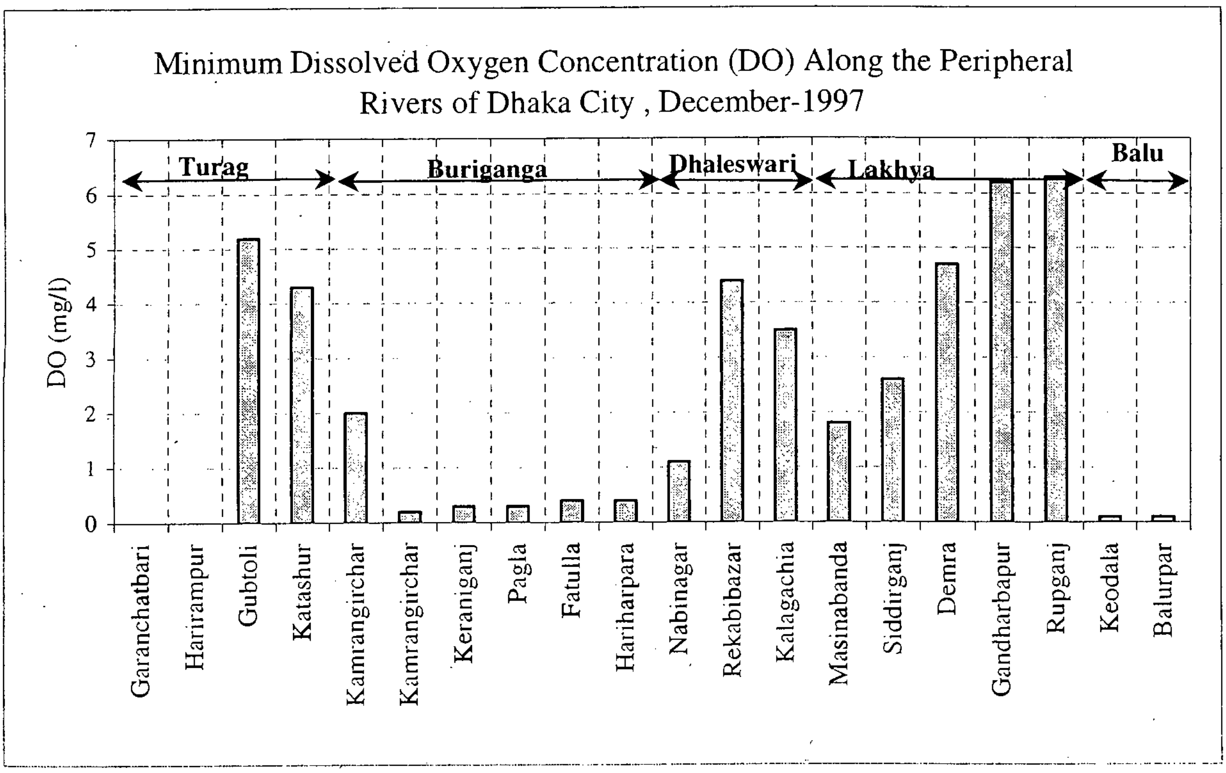


Figure B.2.4 : Minimum DO Concentration in the Peripheral Rivers , December-1997
(Source: WSP International, 1998)

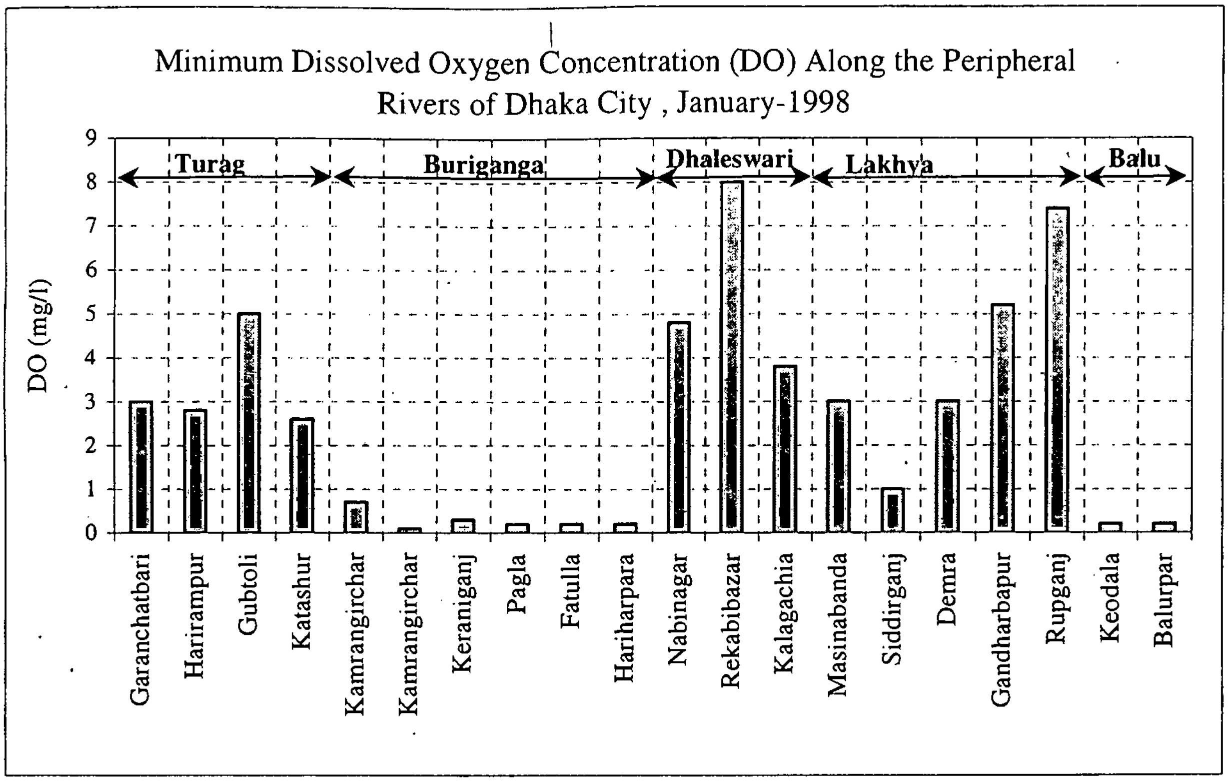


Figure B.2.5 : Minimum DO Concentration in the Peripheral Rivers , January-1998
(Source: WSP International, 1998)

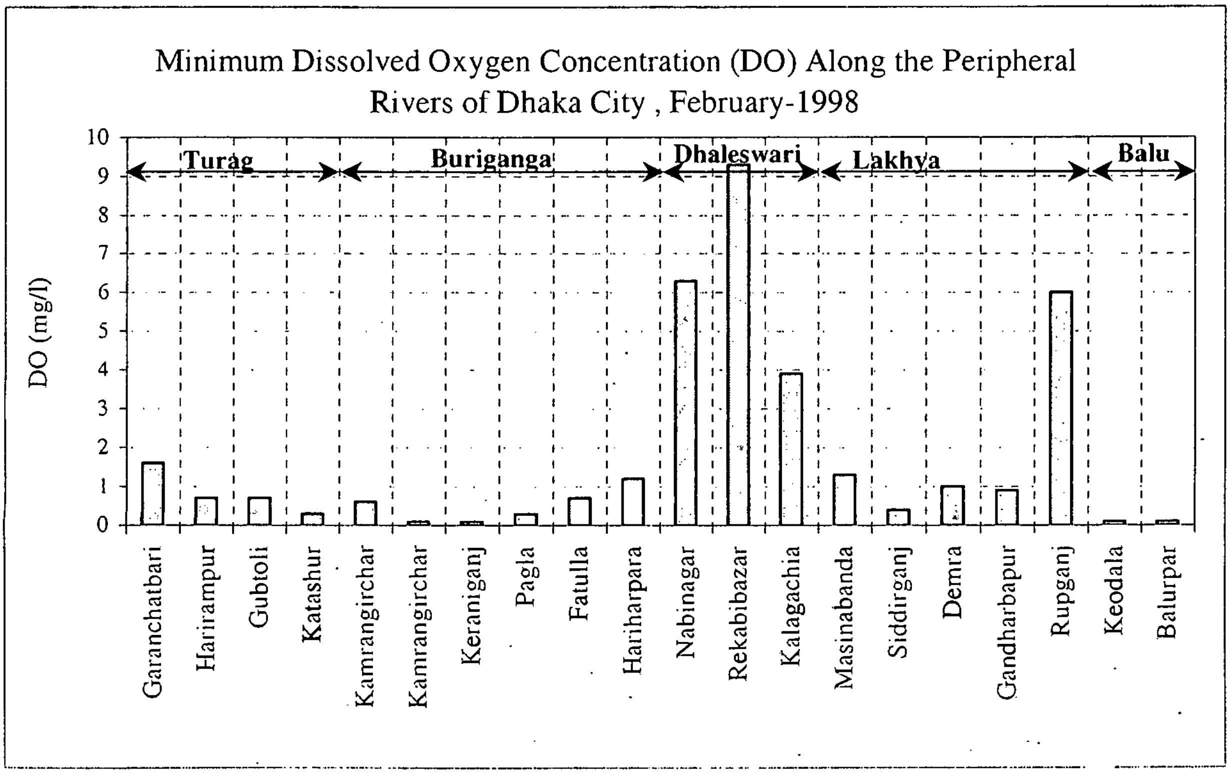


Figure B.2.6 : Minimum DO Concentration in the Peripheral Rivers , February-1998
(Source: WSP International, 1998)

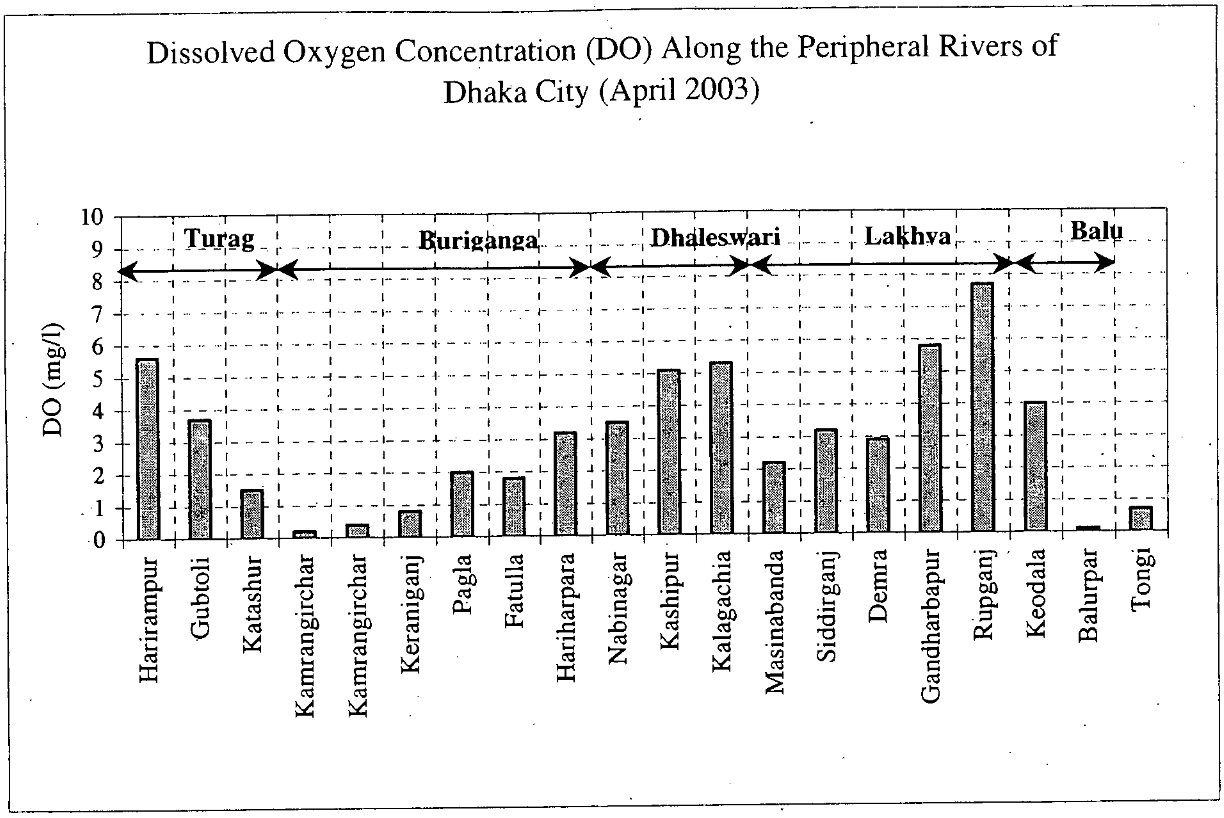


Figure B.2.7 : DO Concentration in the Peripheral Rivers , April-2003
(Source: IWM, 2005)

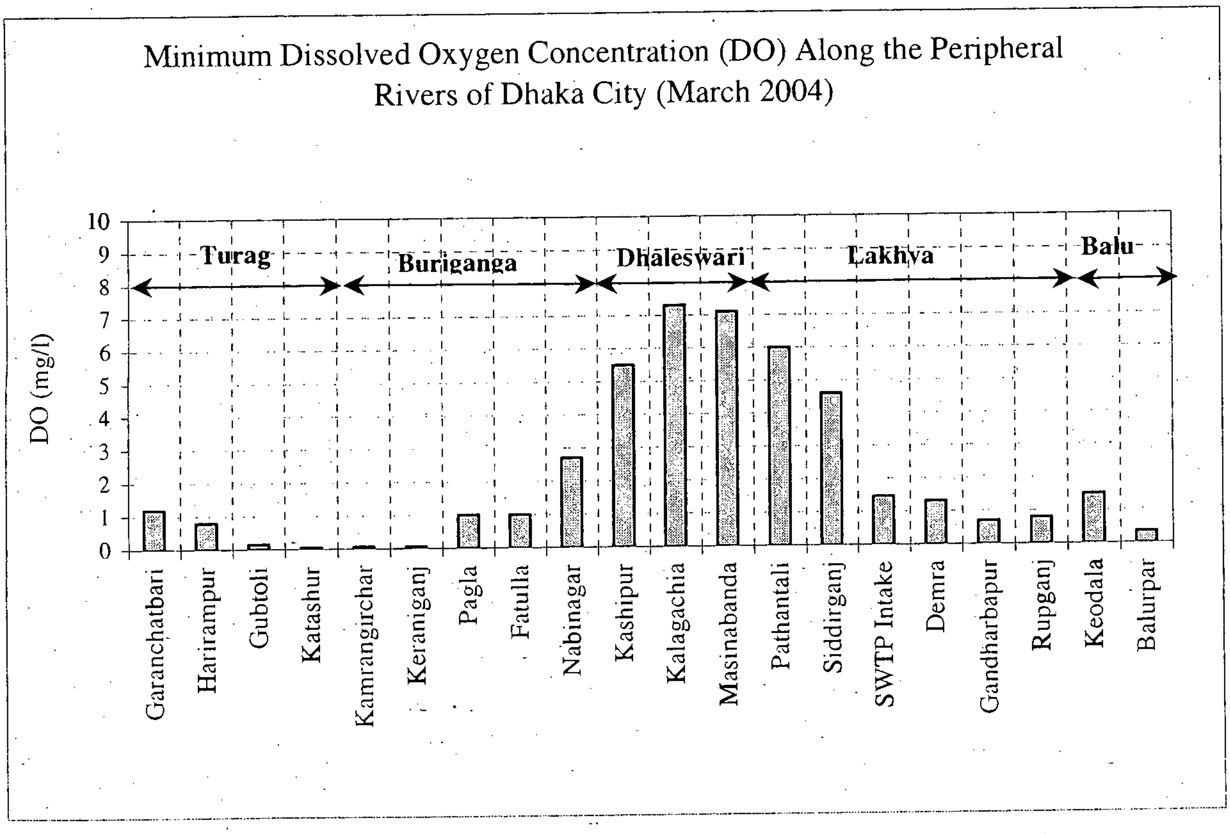


Figure B.2.8 : Minimum DO Concentration in the Peripheral Rivers , March-2004
(Source: IWM, 2005)

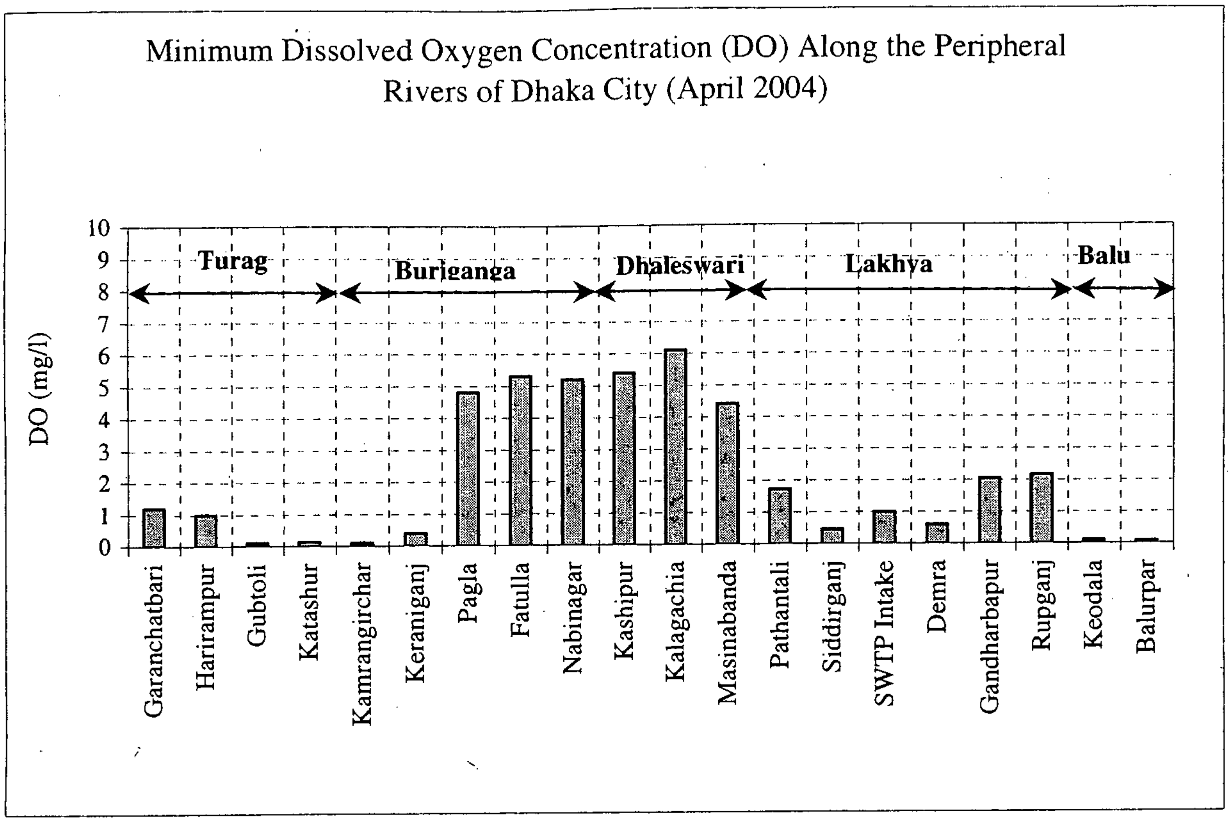


Figure B.2.9 : Minimum DO Concentration in the Peripheral Rivers , April-2004
(Source: IWM, 2005)

APPENDIX-C

Figures of Water Quality in Streams

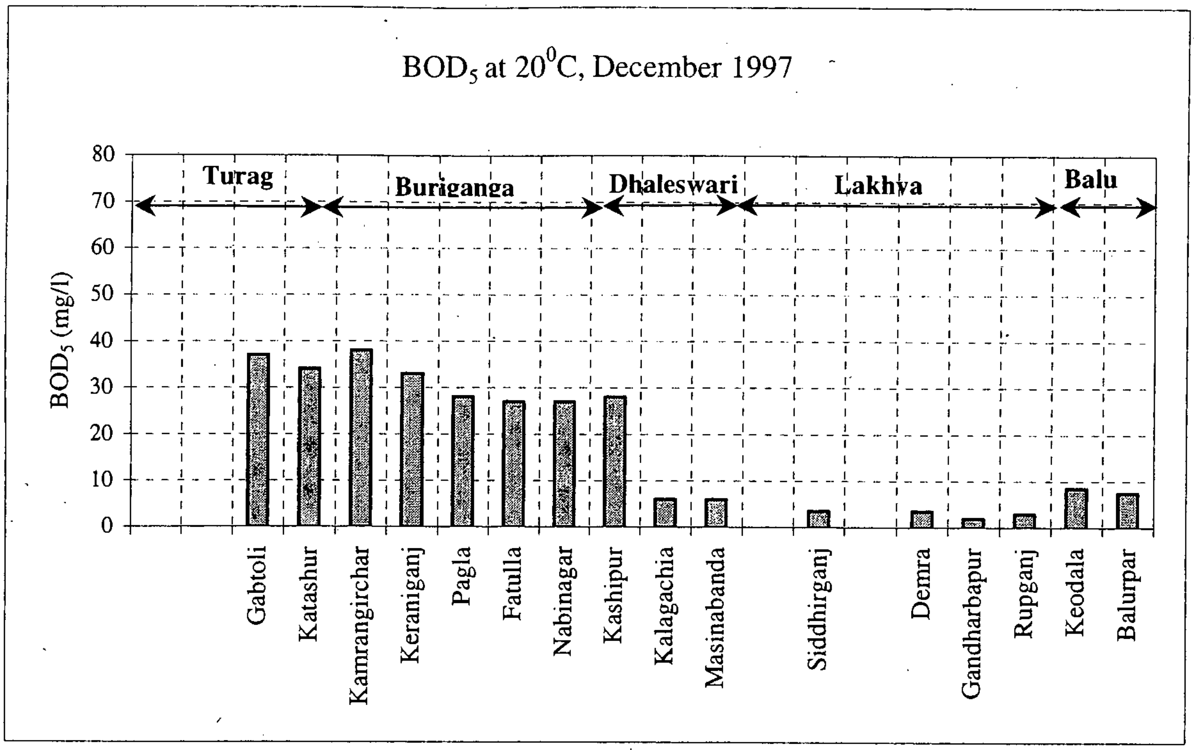


Figure C.1 BOD$_5$ at 20 ^{0}C during December 1997 along the peripheral rivers of Dhaka City
(Source: WSP International, 1998)

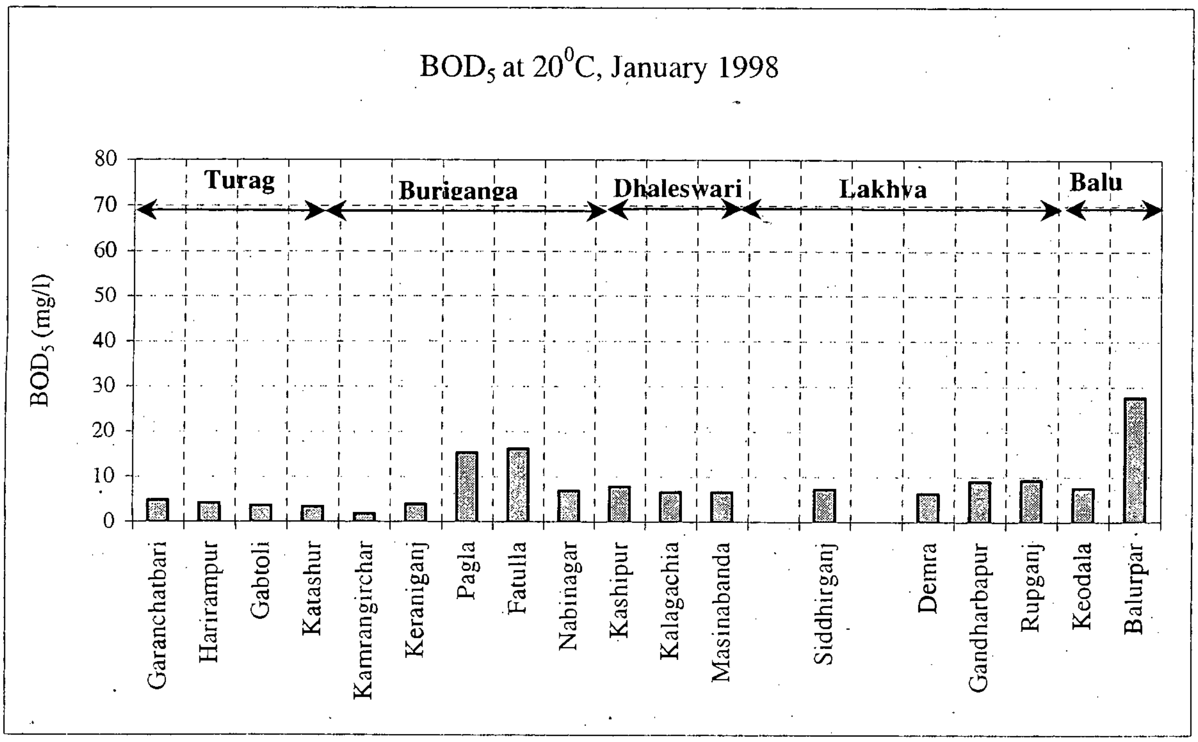


Figure C.2 BOD$_5$ at 20 ^{0}C during January 1998 along the peripheral rivers of Dhaka City
(Source: WSP International, 1998)

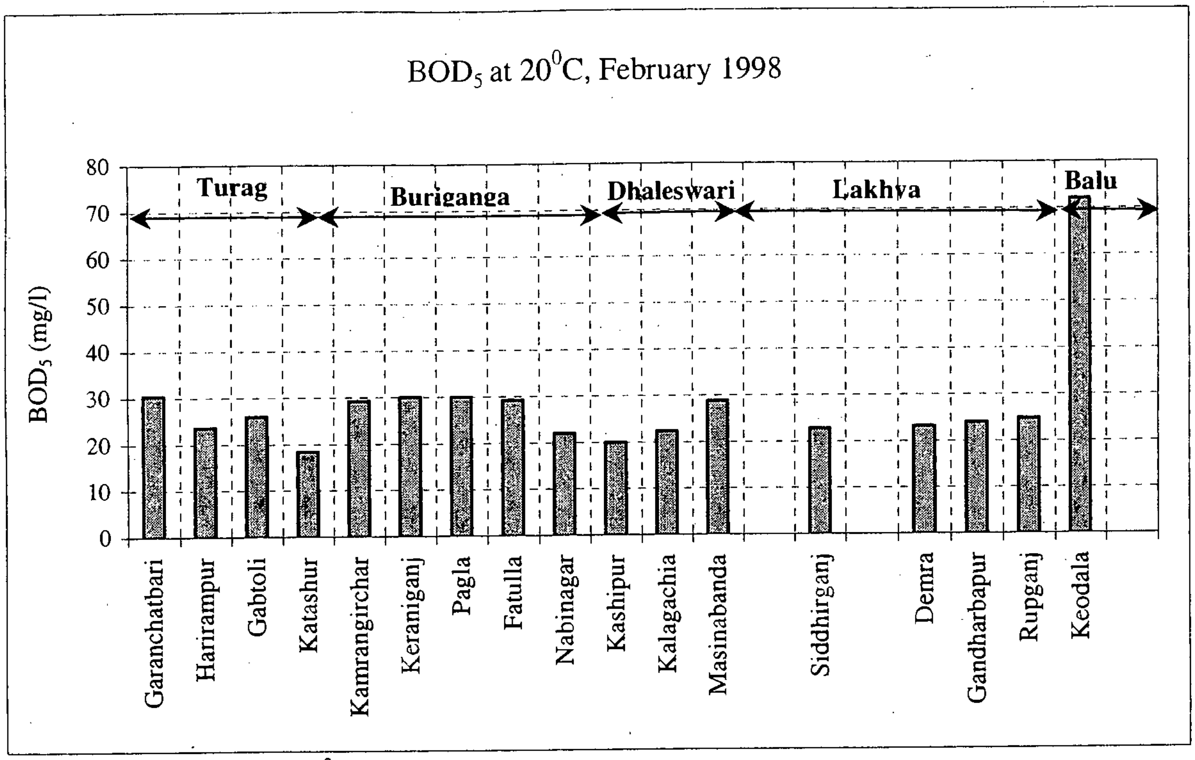


Figure C.3 BOD$_5$ at 20 ^{0}C during February 1998 along the peripheral rivers of Dhaka City
(Source: WSP International, 1998)

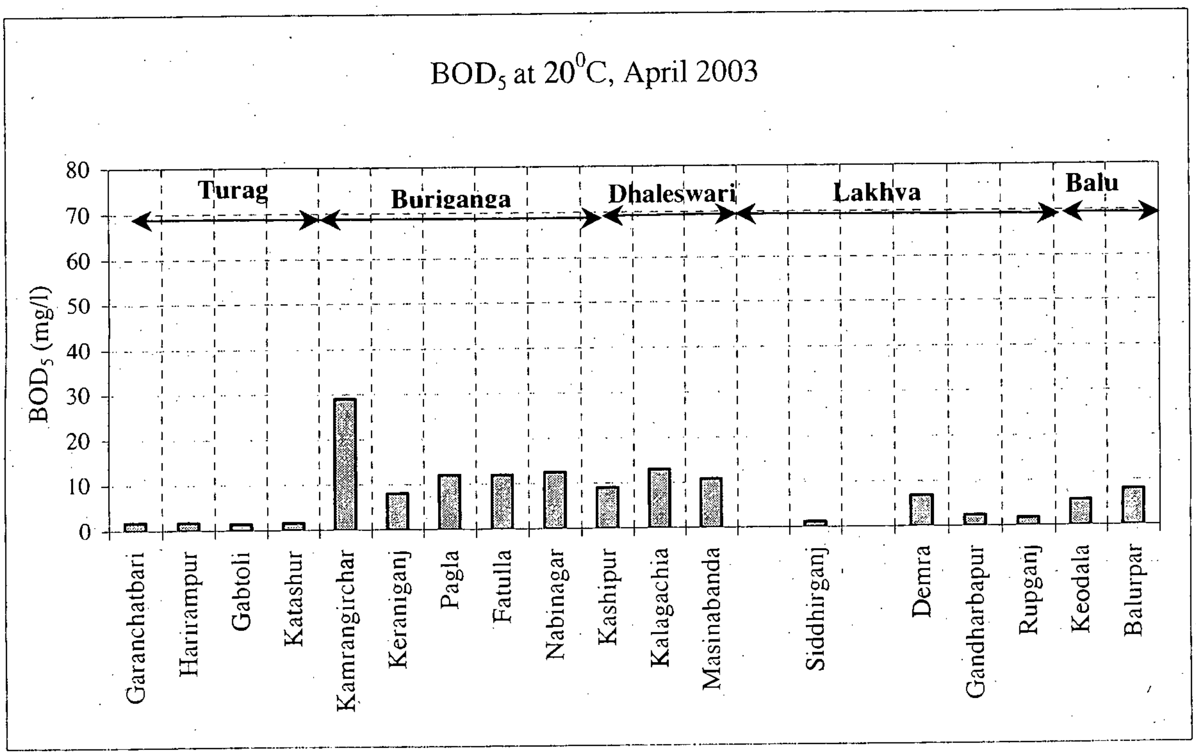


Figure C.4 BOD$_5$ at 20 ^{0}C during April 2003 along the peripheral rivers of Dhaka City
(Source: IWM, 2005)

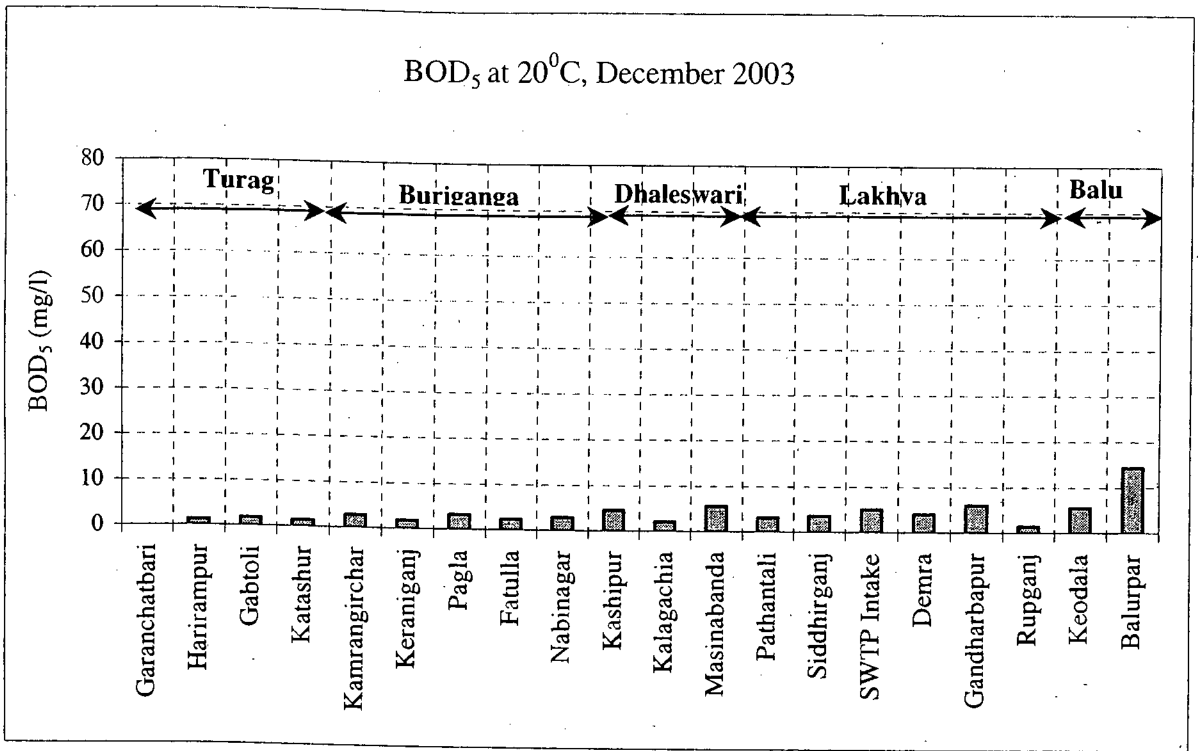


Figure C.5 BOD$_5$ at 20 ^{0}C during December 2003 along the peripheral rivers of Dhaka City
(Source: IWM, 2005)

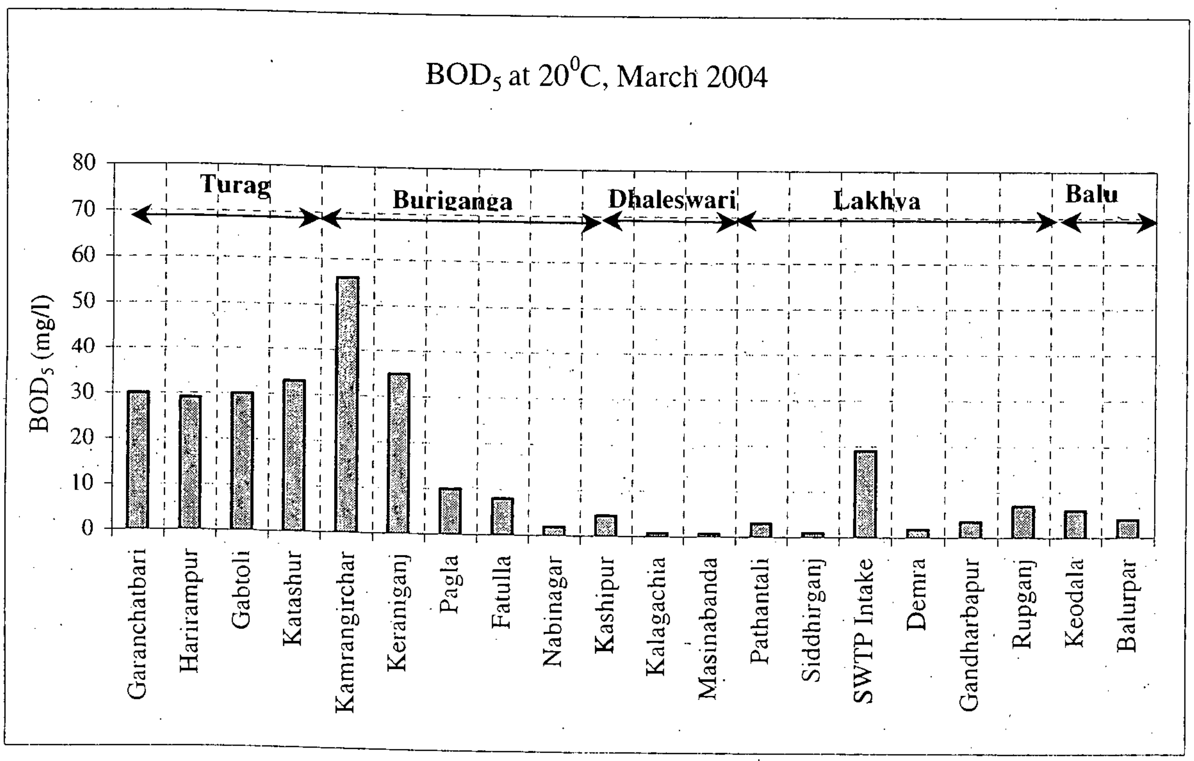


Figure C.6 BOD$_5$ at 20 ^{0}C during March 2004 along the peripheral rivers of Dhaka City
(Source: IWM, 2005)

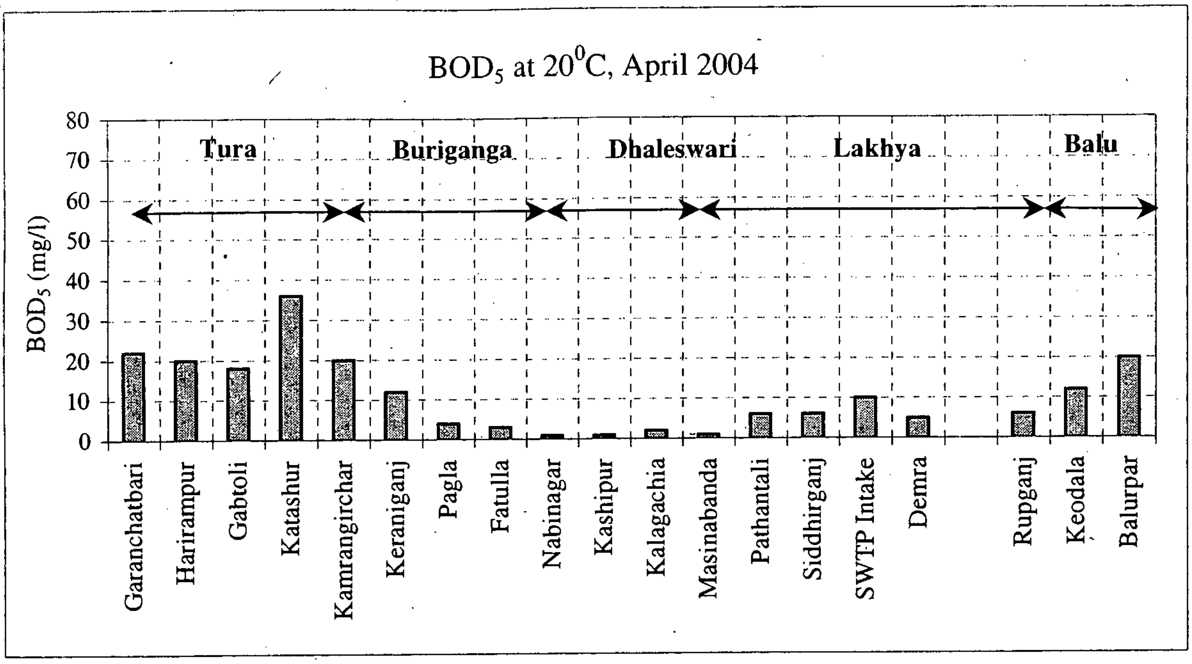


Figure C.7 BOD$_5$ at 20 ^{0}C during April 2004 along the peripheral rivers of Dhaka City

(Source: IWM, 2005)

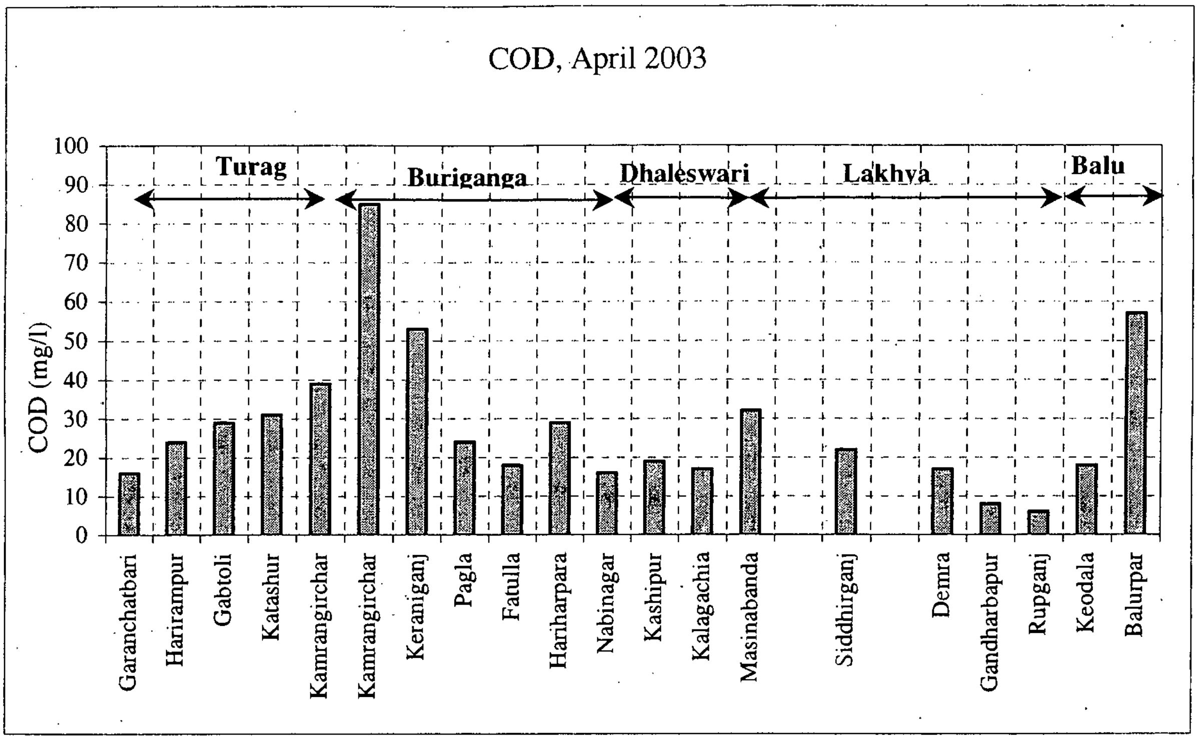


Figure C.8 COD ($K_2Cr_2O_7$) during April 2003 along the peripheral rivers of Dhaka City
(Source: IWM, 2005)

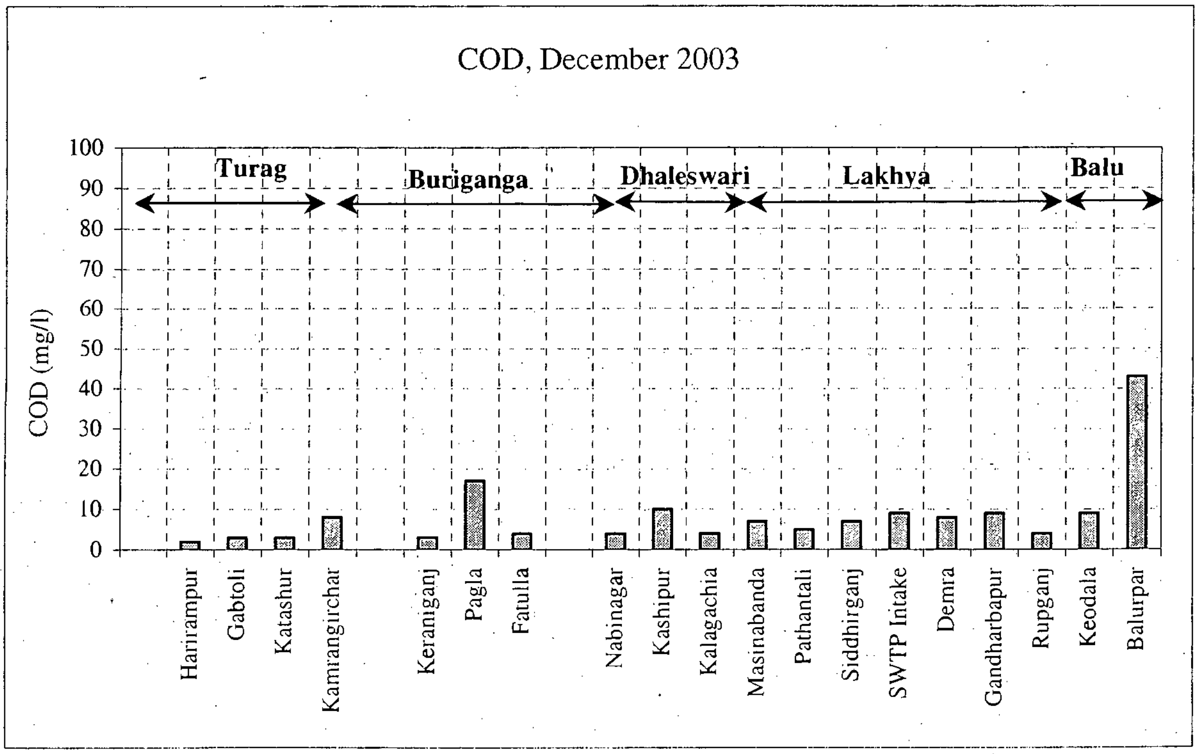


Figure C.9 COD ($K_2Cr_2O_7$) during December 2003 along the peripheral rivers of Dhaka Ci
(Source: IWM, 2005)

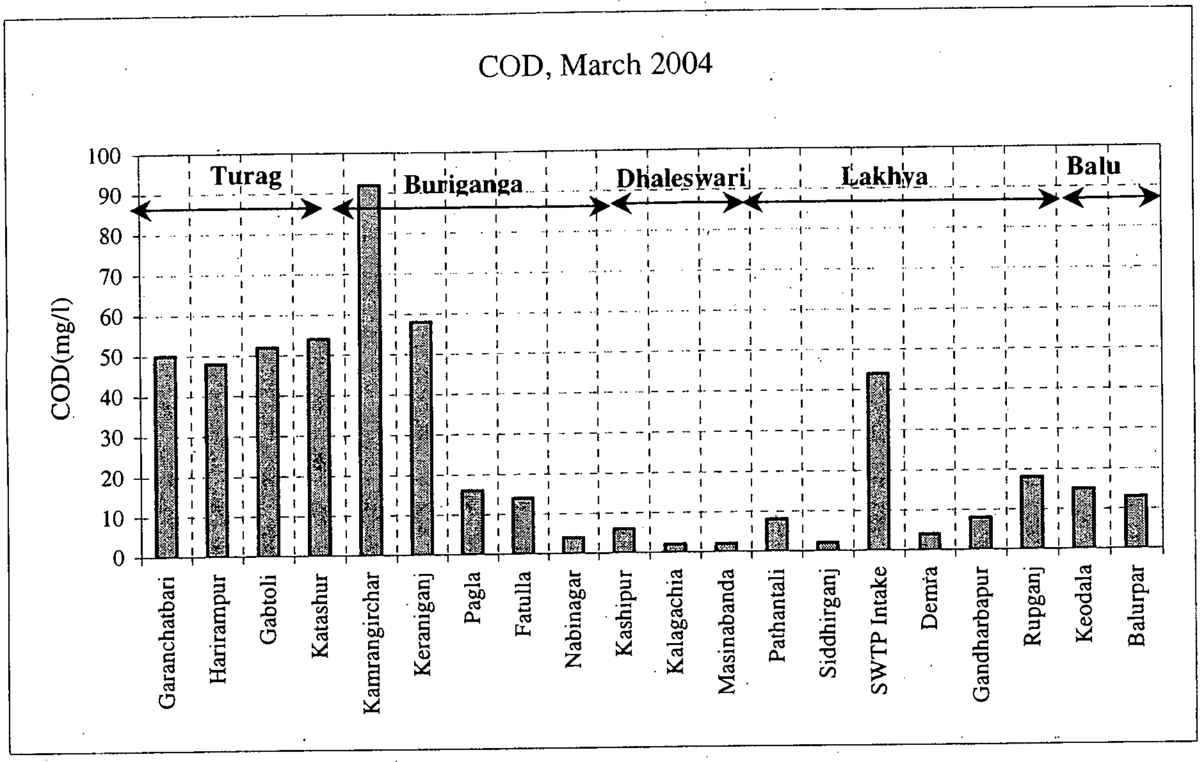


Figure C.10 COD ($K_2Cr_2O_7$) during March 2004 along the peripheral rivers of Dhaka City
(Source: IWM, 2005)

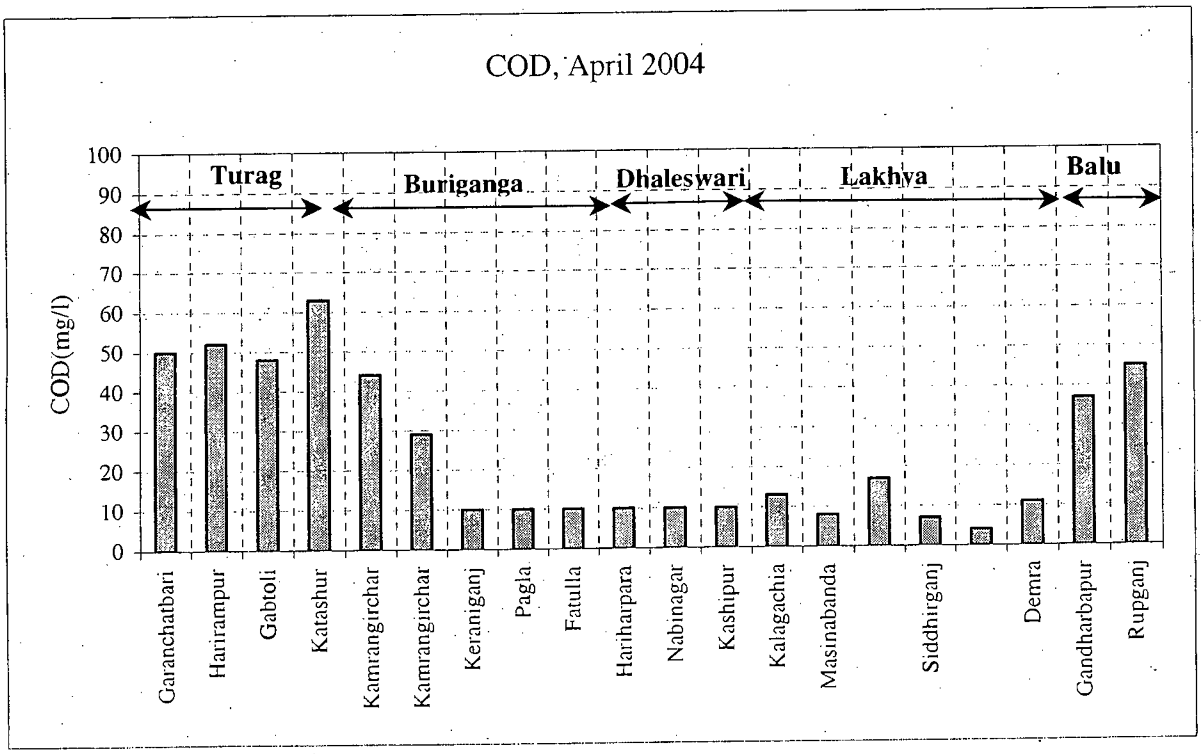


Figure C.11 COD ($K_2Cr_2O_7$) during April 2004 along the peripheral rivers of Dhaka City
(Source: IWM, 2005)

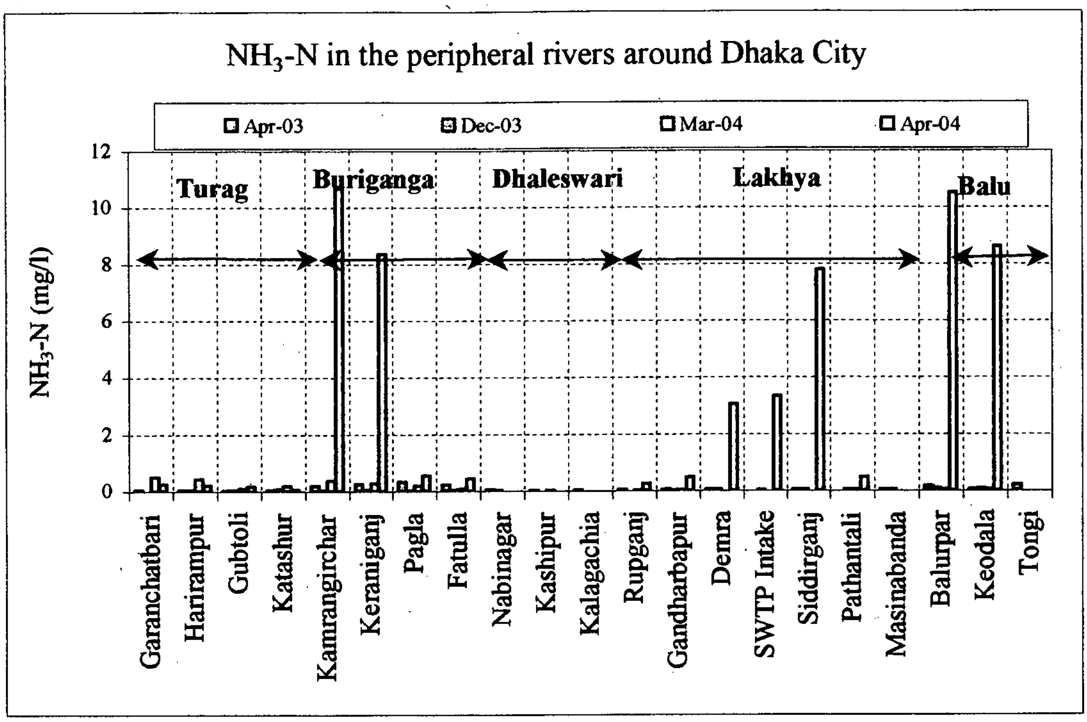


Figure C.12 : Measured NH_3-N Concentration along the Peripheral Rivers around Dhaka City (Source: IWM, 2005)

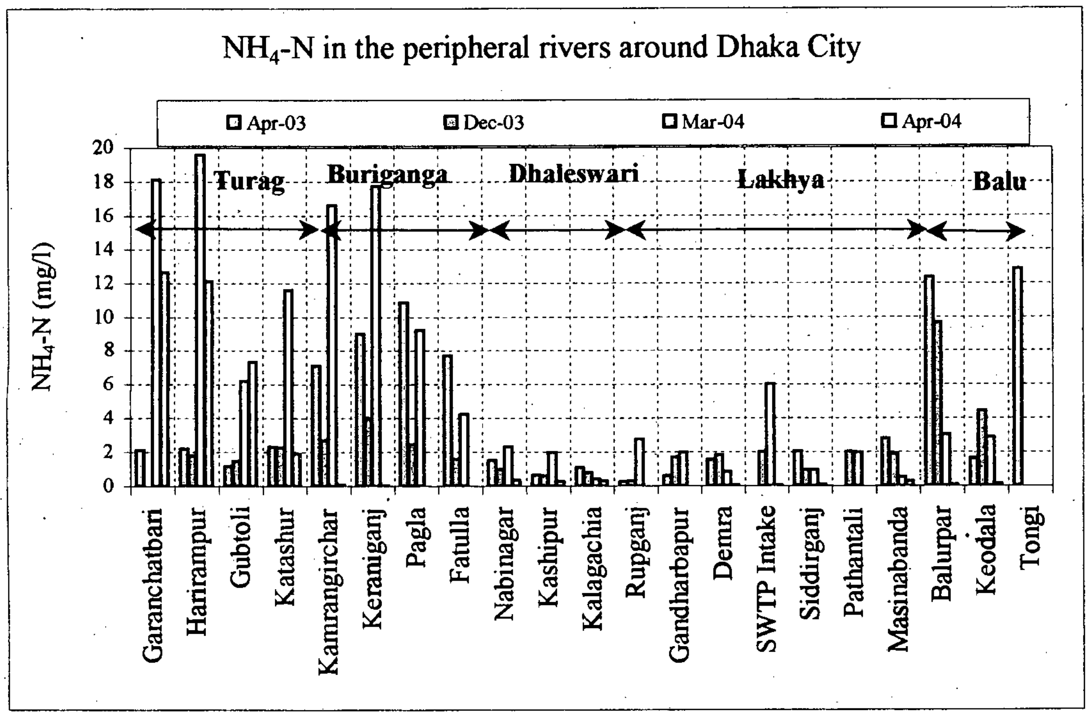


Figure C.13 : Measured NH_4^+-N Concentration along the Peripheral Rivers around Dhaka City (Source: IWM, 2005)

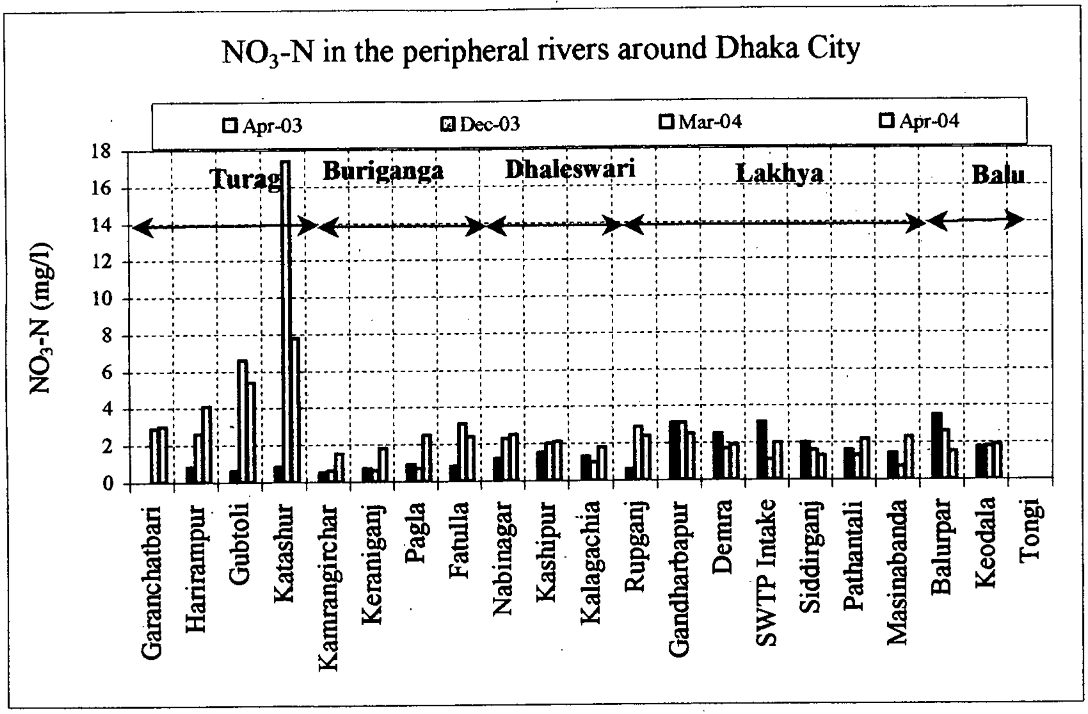


Figure C.14 : Measured NO_3^--N Concentration along the Peripheral Rivers around Dhaka City (Source: IWM, 2005)

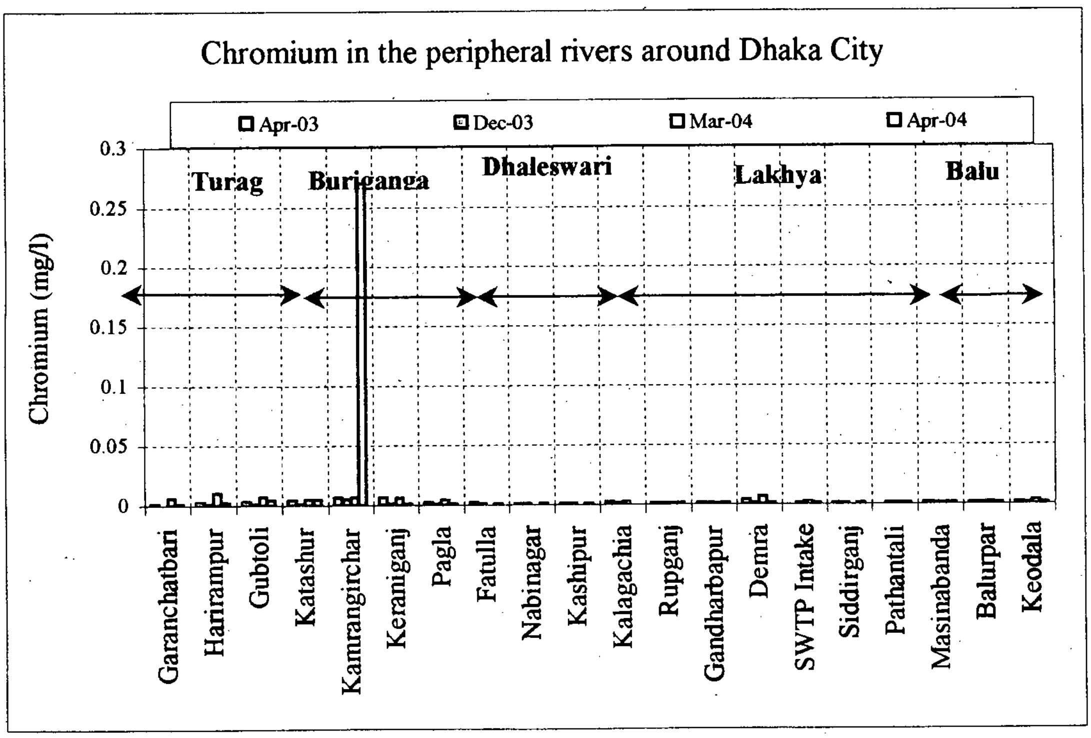


Figure C.15 : Measured Chromium Concentration along the Peripheral Rivers aroun Dhaka City (Source: IWM, 2005)

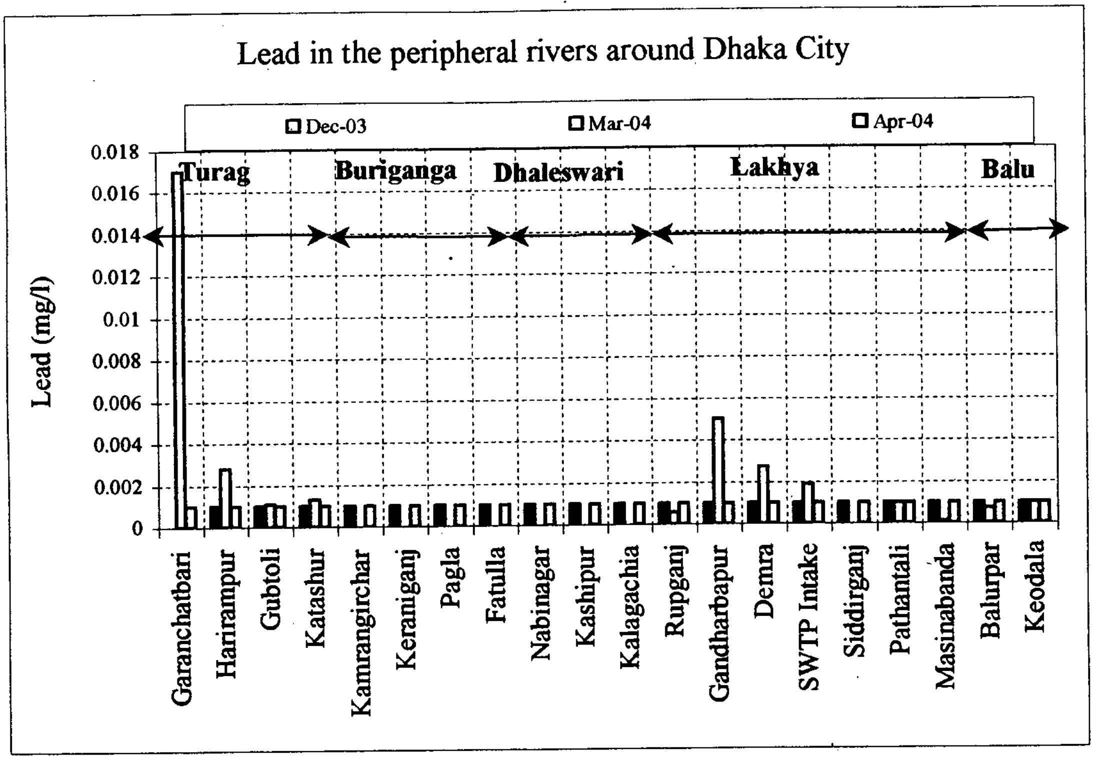


Figure C.16 : Measured Lead Concentration along the Peripheral Rivers around Dhaka City (Source: IWM, 2005)

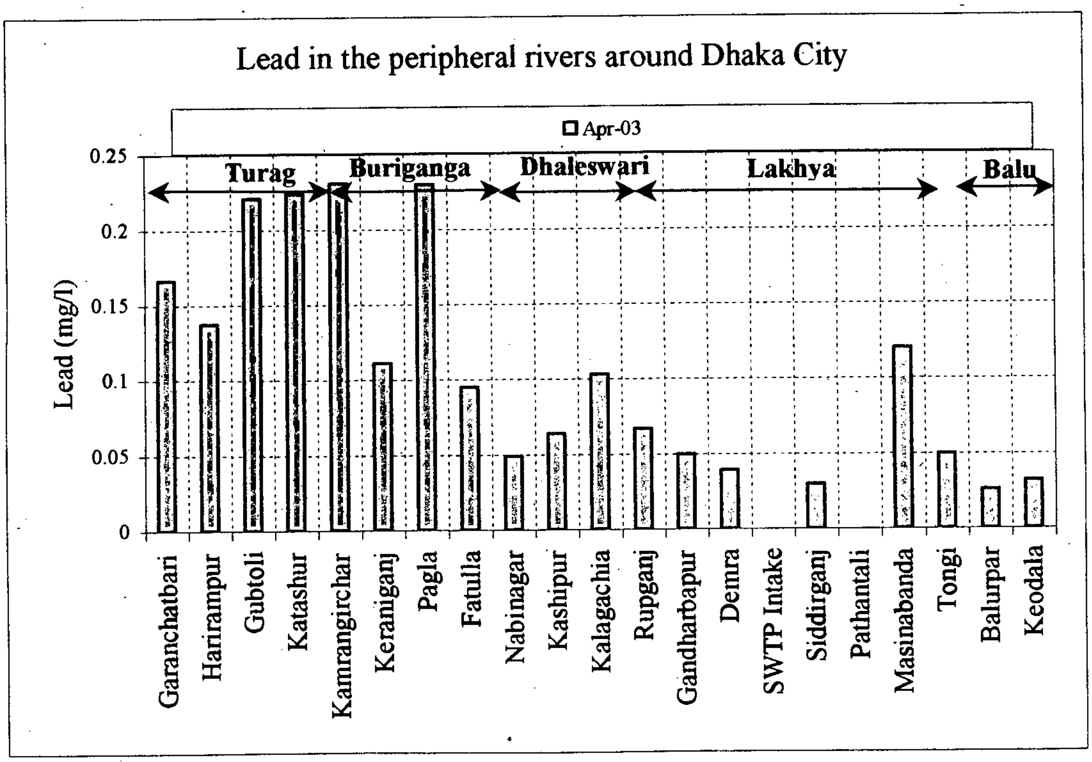


Figure C.17 : Measured Lead Concentration along the Peripheral Rivers around Dhaka City (April 2003) (Source: IWM, 2005)

APPENDIX-D

Figures of Historical Water Quality in Some Wastewaters Outlets

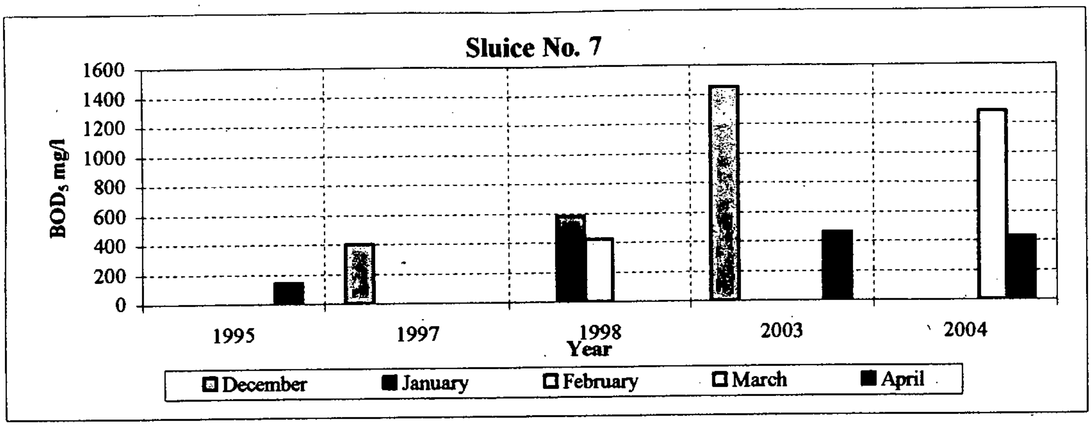


Figure D.1: Historical BOD_5 (at 20^0C) at Sluice No. 7 (Katashur)
(Source: Kamal, 1996; WSP International, 1998; IWM, 2005)

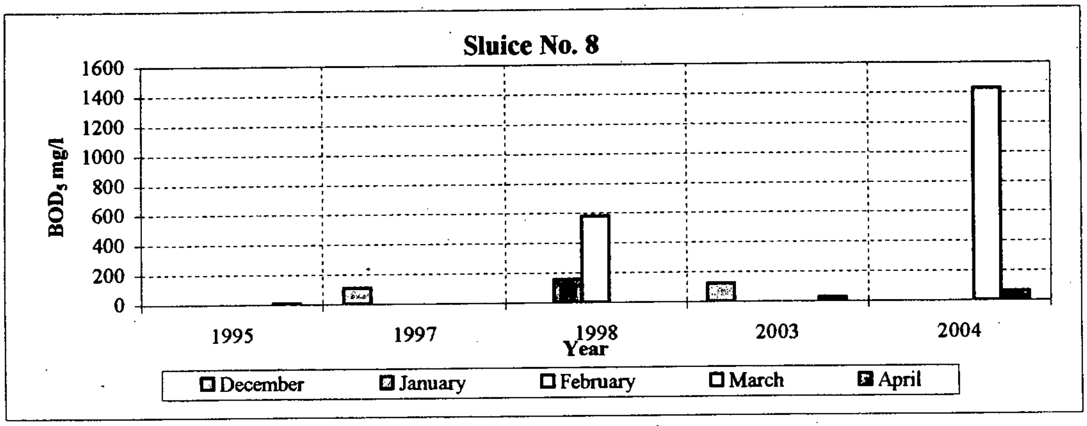


Figure D.2: Historical BOD_5 (at 20^0C) at Sluice No. 8 (Hazaribag)
(Source: Kamal, 1996; WSP International, 1998; IWM, 2005)

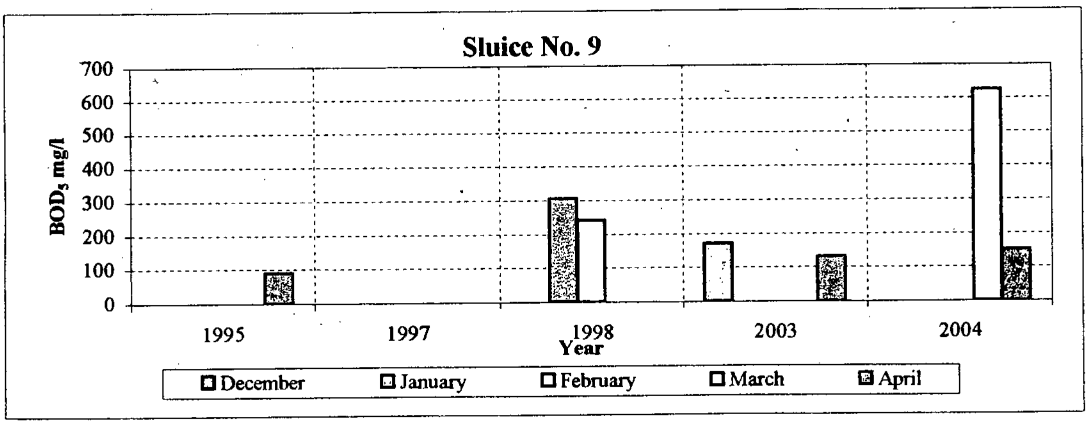


Figure D.3: Historical BOD_5 (at 20^0C) at Sluice No. 9 (Islambag)
(Source: Kamal, 1996; WSP International, 1998; IWM, 2005)

Note: the data presented above is based on single measurement in a day, thus it does not represent the whole year. Yet it has been presented with respect to year and month just for understanding

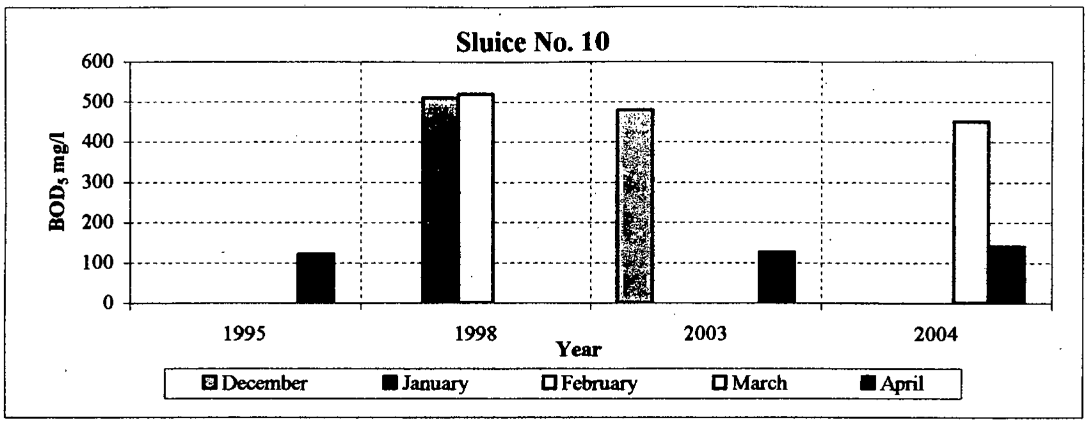


Figure D.4: Historical BOD_5 (at 20^0C) at Sluice No. 10
(Source: Kamal, 1996; WSP International, 1998; IWM, 2005)

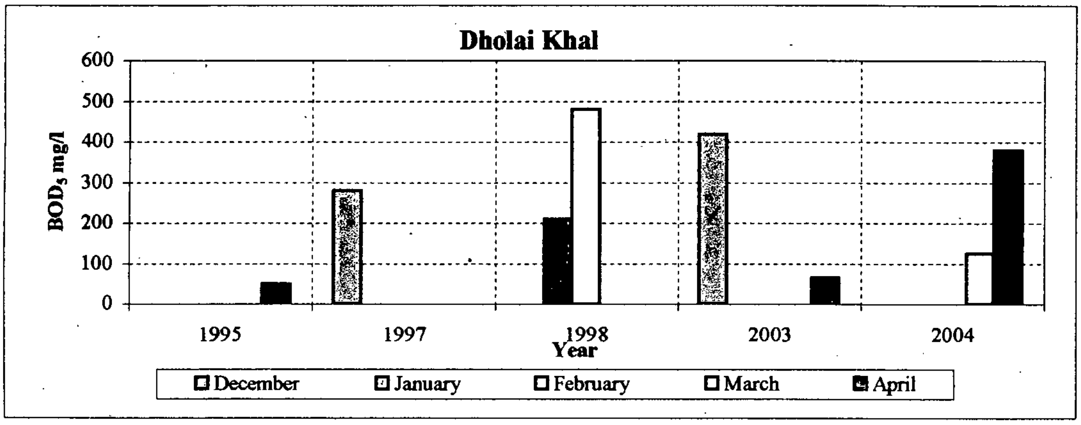


Figure D.5: Historical BOD_5 (at 20^0C) at the Outfall of Dholai Khal
(Source: Kamal, 1996; WSP International, 1998; IWM, 2005)

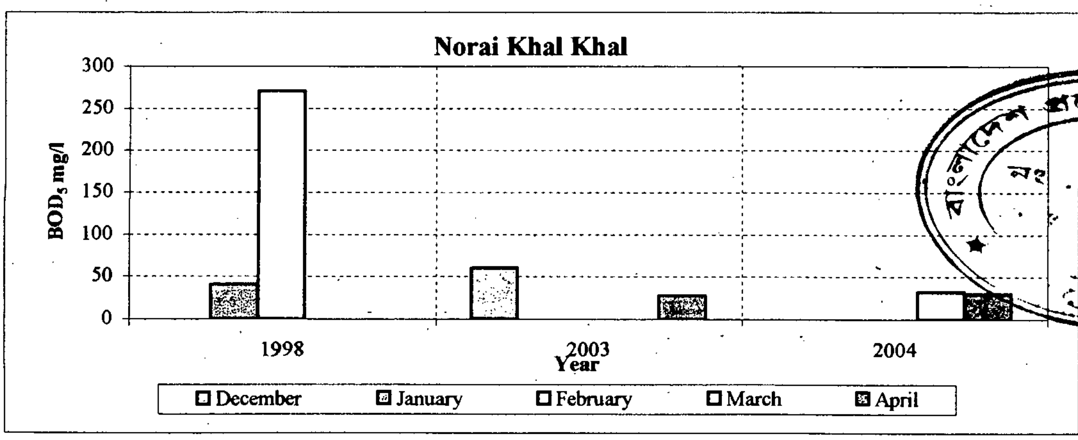


Figure D.6: Historical BOD_5 (at 20^0C) at the Outfall of Norai Khal
(Source: Kamal, 1996; WSP International, 1998; IWM, 2005)

Note: the data presented above is based on single measurement in a day, thus it does not represent the whole year. Yet it has been presented with respect to year and month just for understanding