POLLUTION OF RIVER YAMUNA AND ITS CONTROL IN DELHI

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CERTIFICATE

This is to certify that the work contained in this dissertation entitled *"**Pollution of River Yamuna and its Control in Delhi**"* by **Sudesh Kumar Chauhan,** University Roll No. 13991 in the requirement for the partial fulfillment for the award of the degree of Master of Engineering in Civil Engineering (Environmental Engineering), is a record of bonafide work carried out by him under my supervision and guidance. He has fulfilled the requirement of submission of the thesis, which to my knowledge has reached requisite standards. The result contained in the dissertation has not been submitted in part or full in any other university of institute for award of degree or diploma.

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ABSTRACT

The River Yamuna originates from the Yamunotri in the Himalayas. It finally merges with the Ganga and Underground Saraswati at Prayag in Allahabad. Enroute it runs for approximately 22 Km along Delhi. This river quenches the thirst of almost 60% population of Delhi and in return it is cursed to become a practically dead river, which can resemble more than drain than to river. In lower reaches its water is good for nothing. This is alarming situation towards the environment degradation as mentioned above.

The objective of this project is to study the quality of River Yamuna, to identify the sources of pollution of River Yamuna and to suggest preventive measures for prevention of pollution in River Yamuna. The most alarming finding of the study is the total lack of dissolved oxygen in the entire reach (from wazirabad barrage to Okhla barrage), biochemical oxygen demand is more than limits at all the locations and unbelievably high coli forms count.

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CHAPTER 1
INTRODUCTION

1.1 GENERAL

The River Yamuna is one of the major rivers of India. It is a tributary of River Ganga and as sacred as the great River Ganga itself. It has been acclaimed as a holy river in Indian mythology and various pilgrimage centers e.g. Yamunotri (Uttranchal), Paonta Sahib (Himachal Pardesh), Mathura, Vrindavan, Bateshwar & Allahabad (all in Uttar Pradesh) are located at the banks of this river. Large urban centers e.g. Yamuna Nagar, Sonipat, Delhi, the political nucleus of India, Gautam Budh Nagar, Faridabad, mathura, Agra and Etawah are also established on its banks. Large industrial centers have also been developed either on banks or in its basin. In agriculture front also the yamuna basin is one of the highly fertile and high food grain yielding basins, especially areas in Haryana and Western districts in Uttar Pardesh. All this reflects that the River Yamuna not only flows in the hearts of Indian but also plays a significant role in the economy of the country.

The total length of Yamuna River is 1376 km traversing through five states. The main stream of river originates from the Yamunotri glacier (Saptrishi Kund) nearBander Punch peaks (38^0 59' N 78^0 27'E) in the Mussoorie range of the lower Himalayas at an elevation of about 6320 meter above mean sea level in Uttrakashi district of Uttranchal. The head waters of yamuna river are formed by several melt streams, the chief of them gushing out of the morainic smooth at an altitude of 3250 m, 8 km

North West of Yamunotri, hot springs at the latitude 31^0 2'12'' N and longitude 78^0 26'10''. Arising from the source, the river flows through series of curves and rapids for about 120 km to emerge into Indo-Gangetic plains at Dak Patthar in Uttranchal. At Dak Patthar the river water discharge is regulated through a weir & diverted into a famous Sikh religious centre Paonta Sahib (Himachal Pradesh) and reaches Hathnikund in Haryana where the major part of river water is diverted, no water is allowed to flow in the river, downstream to Hathnikund barrage. The river is almost dry in some stretches between Hathnikund and Delhi. Downstream of Hathnikund the river regain water from ground water accrual and contributions of feeding canals and small tributaries etc. From Hathnikund the river sluggishly meanders and reaches Delhi at Palla after traveling a distance of about 224 km.

1.1.1 Various Segments of Yamuna River

The water flow characteristics of Yamuna River significantly vary from monsoon to non-monsoon seasons. This change in water flow alongwith the construction of various barrages hampers the continuous flow of the river. Thus, in dry season (almost nine months), the river becomes segmented in four distinguished independent segments.

Segment I: This segments (length 157 km) is identified from Yamunotri and terminate at Hathnikund/Tajewala barrage. The major source of water in this segment is the melting of glaciers.

Segment II: This segment (about 224 km) lies between Hathnikund/Tajewala barrage and Wazirabad barrage. The main source of water in this segment is ground water accrual. Few small tributaries also contribute water in this segment. The water is diverted in this segment to fulfill the raw water demand for drinking water supply in Delhi.

Segment III: This 22 km segment of Yamuna River is located in between Wazirabad barrage and Okhla barrage. This segment receives water from drains of Delhi.

Segment IV: This Segment of Yamuna River is about 973 km long initiate immediately downstream to Okhla barrage and extends upto confluence to Ganga River at Allahabad. The source of water in this segment are ground water accrual, its tributaries like Hindon, Chambal, Sindh, Ken, Betwa etc. and waste water carrying drains of Delhi, Mathura-Vrindavan, Agra and Etawah. The water of this segment is used for drinking and industrial uses at Mathura & Agra.

1.1.2 Origin of River Yamuna

The origin of River Yamuna is at Yamuntori, in the Uttarakhand, which lies north of Haridwar in the Himalayan Mountains. The river flows through the states of Delhi, Haryana and Uttar Pardesh, before confluencing with the Ganges at Allahabad. The cities of Baghpat, Delhi. Mathura, Noida, Etawah, Agra, Hamirpur, Allahabad and Kalpi lies on its banks. The major tributaries of the river are the Tons, Chambal, Betwa and Ken; with the Tons being the largest.

1.1.3 History of River Yamuna

The History of River Yamuna is significant because of the importance of this river in Indian mythology. Some ancient evidence indicated that River Yamuna was a tributary of the Ghaggar River in the past; with time it changed its course to east with a tectonic event in north India and became a tributary of the Ganga instead. The godess of the Yamuna River, also known as Yami is the sister of Yama, god of death, and the daughter of Surya, the Sun god, and his wife Samin. Consequently, popular belief is that those who take a dip in its holy waters are not tormented by fears of death. It is also connected with Lord Krishna's past times. The Lord Krishna sanctified the River Yamuna, while his father Vasudeva was crossing the Yamuna with baby Lord Krishna.

1.1.3 Geography of River Yamuna

The Geography of River Yamuna is closely related to the topography and the geographical formation of Northern India. Yamuna River is a river of northern India. River Yamuna is the longest tributary of the Ganges River, having length of approximately 860 miles. The source of the Yamuna happens to be in the western Himalayas. The river initially flows south and then southeast, thus running parallel to and just west of the Ganges.

River Yamuna enters Delhi near Palla at an altitude of 210.3 meter and transverse of about 40 km, it leaves Delhi at and altitude of 198.2 meter near Jaitpur in the south.

The river is trapped at Wazirabad through a barrage for drinking water supply to Delhi. Generally, no water is allowed to flow beyond Wazirabad barrage in dry season, as the available water is not adequate to fulfill the demand of water supply of Delhi.

Whatever water flows in the downstream of Wazirabad barrage is the untreated or partially treated domestic and industrial wastewater contributed through several drains along with the water transported by Haryana Irrigation Department from Western Yamuna Canal (WYC) to Agra Canal via Najafgarh Drain. After 22 km downstream of Wazirabad barrage there is another barrage, Okhla barrage, through which Yamuna water is diverted into Agra Canal for irrigation. No water is allowed to flow through barrage during dry season. Whatever water flows in the river beyond Okhla barrage is contributed through domestic and industrial waste water generated from East Delhi, Noida and Sahibabad and joins the river through Shahdara drain. The yamuna after receiving water through other important tributaries joins the river Ganga and the underground Saraswati at Prayag (Allahabad) after traversing about 950 km. Thus, Yamuna river cannot be designated as continuous river particularly in dry seasons (almost 9 months), but can be segmented in five distinguished independent segments due to characteristics hydrological and ecological conditions. The Yamuna River may be

disintegrated into 5 segments due to their hydrological & ecological condition. These segments are Himalayan segment, upper segment, Delhi segment, Eutrophicated segment and diluted segment. The first two segments are comparatively clean having oligotrophic condition. Delhi segment is the most polluted segment in the entire Yamuna River. This segment has obligotrophic head and saprobic tail. Eutrophicated segments except few patches of seprobic condition have diurnal variation of oxygen levels, an indication of eutrophication. The stretch of Yamuna River after its confluence with Chambal River is termed as diluted segment, as it receives significant dilution water. This segment after confluence with Chambal River regain its water quality up to some extent.

1.2 THE OBJECTIVE & NEED OF PRESENT STUDY

The best way is to categorize on the basis of identification of processes & agencies involved in polluting, responsible for controlling and measures adopted or being adopted. As regards polluting process and agencies these can be further categorized as internal, external and ritual/religious. In Delhi reach the river water is polluted by agriculture and industrial waste discharged & culminating into the river in upper reaches mainly from Haryana. These discharges contain organic load, heavy metals and pesticides and fertilizers.

Excessive drawing of water at Tajewala and Wazirabad barrage indirectly contributes to the pollution by reducing the self-purifying capacity of the river. Externally heavy polluting load in form of treated/untreated domestic/ industrial sewage is being poured into the

river in Delhi reach, Religious activity like Purnima Snan, Chhath Pooja, Murty viserjan, disposal of domestic of Residual mortal remains of dead bodies and disposal of domestic pooja/yagyan remains are having large impact on the pollution of river due to heavy population density in Delhi. Besides this jhuggi dwellers residing in the bed & on the bank discharge their all kinds of waste for daily uses they also become the carrier of infectious diseases.

In Delhi the responsible agencies for control of pollution are CPCB, DPCC, MCD, DJB, & DSIDC in government sector. Some N.G.O.'s, judiciary have shown interest in control of pollution. On account of different excuses all these government agencies are showing in-abilities to control the same and can be termed indirectly polluting agencies. Certain measures have been adopted or being adopted to control the pollution and revive the river like setting of S.T.P.'s/ E.T.P.'s/C.T.P's, regular monitoring, increase in fresh water discharge, removal of floating materials, provision of nets in the vicinity of bridges, removal of jhuggies from the Yamuna bank and bed etc.

With all these approaches active in India, and with worldwide acknowledged scientific personnel, the question remains as to the reason for the poor translation of this awareness into ground realities. The present study makes an attempt to deliver some of the reasons after verifying the trend in water quality status is one of the urban river reaches.

The following are the objectives of the present study:-

a) To study the status of River Yamuna.

b) To study the quality of River Yamuna.

c) To identify the sources of Pollution of River Yamuna.

d) To suggest measures for preventions of Pollutions in River Yamuna.

e) To study the various legislations with regard to water quality of River.

CHAPTER 2
LITERATURE REVIEW

2.1 INTRODUCTION

The flow of the Yamuna River varies significantly during monsoon and non-monsoon seasons. The river constitutes maximum flow i.e. around 80% of the total annual flow during monsoon period. The Yamuna cannot be designated as a continuous river but segregated into four independent segments due to the presence of three barrages from where almost the entire water is being diverted for various human activities.

The Urban agglomeration at NCT-Delhi is the major contributor of pollution. The sources contributing pollution are both point & non point type. About 85% of the total pollution in the river is contributed by domestic sources. The condition of river deteriorate further due to abstraction of significant amount of river water, leaving almost no fresh water in the river, which is essential to maintain the assimilation capacity of the river.

About 580 km long river stretch in between Wazirabad barrage and Chambal river confluence is critically polluted. This stretch is characterized by high organic contents, high nutrients, significant depletion in dissolved oxygen, severe odors etc.

The 22 km long Delhi stretch is polluted severely. In this stretch, there was practically no perennial flow during dry whether while a

quantity of treated and untreated sewage (about 3300 MLD) was being discharged into the river. The self-purification capacity of the River Yamuna is due to lack of minimum flow in the river and heavy discharge of 22 drains (treated and untreated) waste in river Yamuna. Even though Delhi constitutes only 2% of the catchments of the Yamuna basin, yet it contributes 80% of the pollution load.

The Unlimited migration coupled with the growth of Govt. offices and complexes has compounded the problem. In the last three four decades, the city has become a major centre of commerce, industry and education, which has led to the spread of the city. Civic amenities have not kept place. The land use regulations have been flouted. The green cover has dwindled.

The contamination of Water has made it unsuitable for drinking, recreation, agriculture and industry, it eventually also diminishes the aesthetic quality of rivers. Even more seriously, when polluted water destroys aquatic life and reduces its reproductive abilities, it eventually menances human health. Nobody escapes the effects of water pollution. When organic matter is discharged into a stream, the decomposable organic matter becomes the food supply of the organisms in aquatic environment. The organic matter is decomposed and converted into the stabilized from at the final state of the decomposition. There are two types of decomposition process, namely aerobic and anaerobic, which are distinct from each other. In the aerobic decompositions process, the dissolved oxygen is consumed for the satisfactions of biochemical oxygen demand where the oxygen required for the decomposition of any

particular quantity of waste is expressed as its biochemical oxygen demand. On the other hand, in the anaerobic decomposition, an undesirable and prolonged septic condition in the stream takes place by production of methane, sulphides, carbon dioxide, ammonia and water as end products.

The present concern for surface water quality has made it necessary for engineers and planners to predict the distribution of pollutants discharged into the river. There is a need to study, analyse and predict the important water quality and quantity vector so that it does not fall below acceptable level. The natural direction and current human actions unfortunately have not been conductive to enhance the environmental state of river basin.

2.2 THE ISSUES REGARDING WATER QUALITY OF RIVER YAMUNA

Most of the rivers including River Yamuna are spiritually regarded as mother. People from all over the country visit various stretches of this river especially at Yamunotri, Paonta Sahib, Mathura-Vrindavan and Bateshwar to take holy dip in river water to purge away their sins. Thus the river portrays Indian culture and traditions. Deteriorated water quality and quantity of Yamuna River hurts the sentiments of Indian masses besides having several adverse impacts on life process in the river.

The issues related with water quality of Yamuna River are described as follows:

2.2.1 DISCHARGE FROM SEWAGE TREATMENT PLANTS INTO THE RIVER

Sewage treatment plants (STP's) have been constructed at various urban centres to conserve the water quality of Yamuna River. The treated, untreated or partially treated sewage from these STP's generally discharged directly or through carrier drain into the river. Prior to installation of STP's the sewage of urban centres was discharged and get mixed with river water at various locations in the wide stretch of river through long & slow transportation system. After installation of STP alongwith swift collection and transport system, the sewage from urban centres concentrated at few places, where STP's are located. The connection of STP with the river sometimes poses great threat to water quality during non-operation of STP due to unavoidable reasons e.g. power failure, mechanical problems or maintenance of plants. In such cases the collected sewage is generally by passed and discharged into the river at few locations without any treatment. Such problem is very significant in those stretches of river where the STP's are located upstream of the river e.g. Mathura- Vrindavan and Agra. The discharges from these STP's located upstream from water abstraction point have impact on the water quality making it unsuitable for various human activities occurring down stream of these STP's.

2.2.2 HIGH ORGANIC CONTENTS

River Yamuna receives significantly high amount of organic matter, which generally, originates from domestic sources. For

biodegradation, this organic waste requires oxygen, causing significant depletion of dissolved oxygen in river water. The oxygen depletion not only affects biotic community of the river but also affects its self-purification capacity. This problem is critical in the river stretch between Delhi and confluence of river with Chambal. In Delhi stretch, the load of organic matter is so high that it consumes the entire dissolved oxygen available in river water.

2.2.3 HIGH NUTRIENTS

The organic matter after biodegradation release nutrients in the water. High nutrients concentration leads to Eutrophication, a condition characterized by significant diurnal variation in dissolved oxygen concentration and excessive algal growth.

2.2.4 EXCESSIVE PRESENCE OF PATHOGENS

Continuous flow of sewage waste, dumping of animal dead bodies etc. and instream uses of water like bathing, cattle wading etc. contribute significant load of pathogens in the river making if unsuitable for drinking and bathing purposes.

2.2.5 ACCUMULATION OF POLLUTANTS IN THE CATCHMENT AREA

Organic, inorganic and toxic pollutants generated from agricultural and industrial sources are accumulated near the source during the seasons and get mixed with river water posing threat to aquatic life during

monsoon or percolated to ground water and making water unfit for human consumption.

2.2.6 AESTHETIC VALUES

Yamuna river is losing its aesthetic value, glory due to severe odour that releases to the surrounding environment from the anaerobic activities occurring in the river strata and the ugly surface look contributed by blackish water, floating of garbage,plastic bags, dead bodies of animals. The religious activities and tourism are greatly affected because of these transformed characteristics of river water.

2.2.7 DEFORESTATION IN THE CATCHMENT AREA

Forest cover in the catchment area of Yamuna is vanishing rapidly. This leads to soil erosion with the rainfall. This results mixing of high amount of silt, mud etc. in the river water, which in tern increases the turbidity. The turbidity of river water is also increased due to direct influx of domestic and industrial wastewater. Increased turbidity has an impact on the productivity of water body besides affecting biotic life of aquatic system.

2.2.8 REDUCTION IN THE QUANTITY OF WATER

The fresh water of Yamuna River is over exploited for irrigation use, drinking and industrial uses resulting very little or sometimes no water in the river at certain locations during summer season. The water scarce condition is so severe that to avoid percolation and evaporation

losses, the Delhi's share of Yamuna water transported through WYC and added back into the river through Drain No.2. All this leads to stagnation of water and formation of dry zones in the drainage area of the river. Non availability of fresh water hampers the purification capacity of the river and causes increase in concentration of pollutants in the river water.

2.2.9 USE OF RIVER STREAM FOR TRANSPORTATION OF WATER

The Delhi stretch of Yamuna River is being used for transportation of water from one water body to another for irrigation purpose by Haryana and Uttar Pradesh. This transportation activity may dilute or add the pollutants affecting the water quality of river.

2.2.10 ENVIRONMENTAL LAWS IN INDIA

Indian laws pertaining to almost aspects of environment like Air, Water, Forest etc. are available separately. A separate protection act covering the entire aspects of environment is also in existence. Though air, water, forest and land are having considerable effect on each other but having more relevance to the study, water Act & EP Act are very relevant here.

2.2.11 WATER QUALITY STATUS OF RIVER YAMUNA AROUND DELHI

Yamuna is the largest tributary of river Ganga and the main source of fresh water is Northern India. Originating from Himalayas, its total length is 1.376 km covering a catchments area of 366.220 km^2 besides

irrigation, The river provides a source of drinking water and bathing. Three major barrages are located on river Yamuna, namely Tajewala, Wazirabad and Okhla, diverting water for irrigation and other uses.

The river water in upper segment is relatively unpolluted. Downstream of Tajewala, domestic and industrial wastewaters from urban and rural areas are discharged into the river. The Delhi Reach, located between two barrages, has practically no perennial flow of its own and receives partly treated and untreated wastewater effluents from Delhi. Therefore, this stretch is the most polluted segment. The BOD load is observed to be 27 mg/1 (almost similar to treated wastewater) at Nizamuddin Bridge in Delhi.

2.3 STANDARDS

A healthy river should contain at least 4 mg/I of Dissolved Oxygen (DO) and a maximum of 3 mg/I of Biochemical Oxygen Demand (BOD)in its water. Pathogens or the disease causing bacteria's indicated by faecal coliforms counts should not exceed 5000 per 100 ml of water. When sewage or industrial effluents containing pollutants (organic matters) are discharged into river, these draw oxygen from the river water for oxidation organic matter. Continuous discharge of pollutants results in depletion of DO in river water adversely affecting the flora and fauna of eco-system. Untreated sewage which also contains pathogenic or faecal matters gives rise to disease causing bacteria in the river water. When people take bath in the river pathogenic bacteria get transmitted to the human body impacting on their health.

Organic pollutants can be removed or minimized by proper treatment of sewage. Treated sewage is required to be disinfected to kill the pathogenic bacteria before it is finally discharged in to water body.

2.3.1 Reasons for Declining Water Quality at Delhi

With the population rising at an alarming rate, the amount of wastewater generated by domestic and industrial activities has increased during 1961-99. There is growing lag between increased wastewater discharge and treatment capacities and this will worsen the quality of existing law water sources and increase the costs for treatment. Domestic sources contribute maximum to wastewater discharges. Industrial discharges, are however, maximum in Rithala and Keshopur zones. The present sewage treatment capacity of Delhi Jal Board (DJB) is of the order of 512 MGD and utilization is only 390 MGD. The DJB on an average, produces about 775 MGD of drinking water. About 80 percent of it returns as wastewater. All most of the unauthorized colonies have no sewers. There is, therefore, a small gap between the sewage treatment capacity presently available and the capacity required treating the wastewater.

Though numerous attempts have been made to clean it, the efforts have proven to be futile. The main reasons for this is due to high density of population living in Delhi, the dumping of untreated water and solid waste in to it (mostly illegally), the lax attitude of the government and mismanagement of projects focused at cleaning it. Also the water in this river remains stagnant for almost 9 months in year aggravating the situation.

2.3.2 Water Quality

Water of the Yamuna River in the capital is not fit for drinking even after treatment of disinfection, as reported by the Central Population Control Board (CPCB). As per the CPCB's best use classification, the quality of water in the river in the stretch between Wazirabad and Okhla was class E, which meant the water was only suitable for irrigation, industrial cooling and controlled waste disposal. However, the quality of water as it entered the city at Palla till Wazirabad, from where industrial activity and dense settlements began, was classified C, indicating it was suitable for drinking after conventional treatment and disinfection.

TABLE 2.1: Characteristics of River Quality at Various Segments

Parameters Average value	Himalyan Segment	Upper Segment	Delhi Segment	Eutrophicated Segment	Diluted
Temps. ^{0}C	19.6	22.4	25.	25.7	24.5
D.O.(mg/1)	8.05	9.7	3.2	6.8	7.9
B.O.D.(Mg/1)	0.6	1.1	17	8.0	1.9
T.D.S.(mg/1)	200	270	563	793	470
R esp. Rate gm./0.2/m^2/d	0.90	1.4	4.6	2.02	1.00
Photosynthesis Rate gm/$^{O}2/m^2$/d	1.02	1.54	0.85	4.49	1.06
Chlorophyltx	500	11.76	36.61	169.5	54
P/r ratio	1.15	1.10	0.18	2.18	$1._{0}6$
Total coliform	7129	9557	10822	45297	11505
Faecal Coliform	172	352	135089	49614	2466
Tropic state	Oligotroplic	Oligotroplic	Polytropic	Antrophic	Oligotroplic

Source CPCB,2000

TABLE 2.2: Primary Water quality criteria for designated best use classes

Designated-Best use	**Class of water**	**Criteria**
Drinking water source without conventional treatment but after disinfection.	A	1. Faceal Coliforms organism MPN/100 ml shall be 50 less. 2. pH between 6.5 and 8.5. 3. Dissolved oxygen 6 mg/I or more 4. Biochemical oxygen demand 5 days 20^0c 2 mg/I or less.
Outdoor Bathing (Organized)	B	1. Faceal Coliforms Organism MPN/100 ml shall be 500 or less. 2. PH between 6.5 and 8.5 3. Dissolved oxygen 5 mg/I or more. 4. Biochemical oxygen demand 5 days 20^0c 3 mg/I or less.
Drinking water source after conventional treatment and disinfections.	C	1. Faceal Coliforms Organism MPN/100 ml shall be 500 or less. 2. PH between 6 and 9 3. Dissolved oxygen 4 mg/I or more. 4. Biochemical oxygen demand 5 days 20^0c 3 mg/I or less.
Propagation of wild life and fisheries	D	1. PH between 6.5 and 8.5 2. Dissolved oxygen4 mg/I or more. 3. Free Ammonia (as N) 1.2 mg/I or less.
Irrigation, Industrial cooling, controlled waste disposal	E	2. PH between 6.0 to 8.5 3. Electrical conductivity at 25^0 C micro mhos/max.2250 4. Sodium absorption ratio max. 26 5. Boron max.2 mg./I

CHAPTER 3
METHODOLOGY

3.1 METHODOLOGY

To ascertain the level of pollution in river Yamuna various parameters are taken into consideration. These parameters include; pH, TDS, COD, DO, BOD. The Data from various sources such as CPCB, DPCC website have been collected for River Yamuna and the drains falling into river Yamuna. Tests were conducted as per standard methods with different instruments.

The different instruments used are:

a) PH Meter

b) DO Meter

c) Multiparameter for TDS

d) COD incubator and Spectrometer

pH Study:- Direct values were taken with the help of PH meter by dipping electrode in the sample. The pH value of water indicates the logarithm of reciprocal of hydrogen concentration present in water. It is thus an indicator of the acidity or the alkalinity of water. Since the pH is the log of reciprocal of H+ the higher value of pH means lower hydrogen ion concentrations, and thus representing acidic solutions.

DO:- DO was found with the help of DO meter. DO meter gives direct values by dipping DO electrode in the sample. In the raw water, the level

of dissolved oxygen gives an idea about the purity of water, because it is the principal parameter responsible for the self- purification of water and for support to aquatic life. Water acutely lacking in dissolved oxygen contains gaseous impurities and substances in their reduced forms, such type of water becomes quite troublesome for the removal of impurities at the time of treatment of water, unless pretreatment of water is done ahead of the conventional water treatment. Deficiency of oxygen in the purified water gives rise to taste & odour problem, as such it is important to ascertain that no deficiency of dissolved oxygen is occurring in the water during its storage, transit & distribution.

COD:- COD was found by taking sample (1ml) and distilled water (1ml) in two different vials and acid reagent (1ml) and potassium dichromate (1.5ml) and then properly mixed. Then the vials were put in the incubation unit for 2 hours at 150 Degree Celsius. Then after cooling COD was found with the help of spectrometer. This test is used for finding out the amount of oxygen required for the chemical oxidation of organic matter existing in the water, and it involves the use of strong oxidant like Pottassium Dichromate under the acidified condition of solution, this test gives an idea about the magnitude of pollution existing in the domestic and industrial waste waters. Therefore the purpose of this test is more or less same as the BOD test. But this test fails to specifically differentiate between the biological degradable organic matter and biological inert organic matter and therefore BOD & COD test cannot be correlated directly. However the

principal merits associated with COD test in that it takes much short time as compared to BOD test.

BOD:- BOD was found by taking values of D O by measuring difference before and after incubation of sample for 5 days at 20 Degree Celsius, Biochemical Oxygen Demand (BOD) refers to the amount of oxygen consumed by bacteria in stabilizing decomposable organic matter biologically under aerobic condition. This test is carried out for knowing the consumption of oxygen by bacteria in 5 days at 20 degrees Celsius, for the biological oxidation of organic matter. Since about 70 to 80 percent of the biological oxidation of organic matter takes place in 5 days, when sufficient oxygen exists in the water and the water environment remains aerobic.

The period of this test is restricted to 5 days, in order to avoid oxidation of ammonia. The purpose of this test is to know about the organic matter existing in the water, which is biologically degradable. Thus it gives an idea about the degree of pollution existing in the raw water of the stage of self-purification process in the raw water. However the principal use of this test is limited to the wastewater treatment for assessing the efficiency of wastewater treatment process and to evaluate pollution load of waste water and its effect on the natural water.

TDS:- TDS was found with the help of electronic balance, oven etc. Total Dissolved solids, as the name suggests, gives the quantity of dissolved solids and in the lab, it is measured quickly & automatically

using the apparatus for determination of conductivity, DO etc. in which we first standardize the instrument for a fixed value of cell constant & then connect it for determination of T.D.S. The Value of Total Dissolved solids should not be more than 1000 mg/litre for irrigation, industrial cooling and controlled waste disposal.

CHAPTER 4
QUALITY OF WATER OF RIVER YAMUNA AT DELHI

4.1 CHARACTERSTICS OF RIVER YAMUNA AT DIFFERENT LOCATIONS IN DELHI

During the past few decades the water quality of the river Yamuna has been degraded. It has been found that 22 km Delhi stretch of River Yamuna from downstream Wazirabad barrage to Okhla barrage is most polluted stretch of River followed by Agra stretch. There is drastic change in Yamuna River water quality from Palla (upstream) to Niazamuddin old bridge and upstream Okhla barrage at Agra Canal as revealed by the water quality data. At Agra, the BOD ranged between 4 to 43 mg/I with annual average of 20 mg/I whereas Total coliform ranged between $2.1x10^6$ to $17.1x10^7$ Nos./100ml. This indicate that the river water quality is not confirming the Total Coliform standard i.e. 5000 Nos/100 ml at most of the locations. The main reasons of pollution in the river is the significant discharge of domestic and industrial waste water from urban centers and over-extraction of river water for drinking and irrigation purposes.

River Yamuna is regularly being monitored by Central Pollution Control Board for assessment of water quality from its origin at Yamunotri to its confluence with Ganga River at Allahabad. The major reasons of water quality degradation are:

1. Rapid industrialization in the river catchment area, discharge of treated & untreated industrial effluents.

2. Increase in the population of towns located on its banks resulting in increased domestic pollution loads.
3. Decrease in flow of river due to intensive use of surface & ground water in catchment area.

TABLE 4.1: Water Quality in River Yamuna During 1990-1998 and 2002

Parameter	Location	Year									
		1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**2002**
PH	PALLA	8.1	8.21	8.00	8.1	8.4	8.0	8.31	8.2	8.22	8.38
	NZB	-	-	-	-	-	7.8	7.6	7.5	8.07	7.54
	OKHLA	7.6	7.7	7.7	7.6	7.6	7.8	7.5	7.4	8.15	7.64
DO	PALLA	8.46	8.1	7.1	7.3	6.9	9.0	9.3	7.5	10.50	9.9
	NZB	-	-	-	-	-	3.0	1.1	1.2	6.00	2.1
	OKHLA	.3	2.3	0.0	2.1	1.9	2.1	1.2	1.3	5.80	4.7
BOD	PALLA	3.00	3.10	3.30	3.60	2.30	2.70	3.10	2.30	2.00	4.00
	NZB	-	-	-	-	-	9.7	8.6	18.4	11.00	36.0
	OKHLA	22.6	25.6	19.0	37.5	49.7	15.0	18.2	16.0	12.0	21.0
COD	PALLA	11.50	12.60	10.20	10.90	8.30	18.20	49.20	9.50	20.00	
	NZB	-	-	-	-	-	31.0	56.1	63.6	67.80	
	OKHLA	69.5	58.2	57.0	108.5	87.0	49.2	72.1	61.5	70.00	
TC	PALLA	-	-	-	5483	36.45	8506	-	-	61000	102000
	NZB	-	-	-	-	-	386091	170318	402312	544000	26100000
	OKHLA	-	-	-	33437	91955	329312	-	-	474000	10000000

Parameter	Location	Year									
		1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**2002**
FC	PALLA	1505	3435	1580	795	193	3944	2901	743	750	6400
	NZB	-	-	-	-	-	141456	142682	376599	262000	1570000
	OKHLA	165710	188900	190210	40450	204250	184967	76136	273875	174000	260000
TKN	PALLA	0.63	0.60	3.10	1.30	1.10	-	-	-	-	
	NZB	-	*	-	-	-	9.19	-	-	-	
	OKHLA	9.2	8.9	9.5	9.2	10.9	13.4	-	-	-	
WT	PALLA	24.3	23.6	24.2	23.6	23.0	23.6	26.2	25.8	26.8	
	NZB	-	-	-	-	-	25.3	27.3	26.5	7.3	
	OKHLA	24.8	24.2	24.0	23.2	23.6	24.6	26.5	26.3	26.5	
AMM	PALLA	0.21	0.2	1.0	0.7	0.3	0.2	0.7	0.4	0.20	
	NZB	-	-	-	-	-	4.6	8.8	10.5	10.37	
	OKHLA	6.8	7.2	3.8	7.4	8.1	7.7	13.3	8.3	8.2	

SOURCE: CPCB,2000

NOTE

NZB : Nizamuddin Bridge
Do : Dissolved Oxygen, mg/1
FC : Faceal Coliform, No./100ml.
BOD : Biochemical Oxygen Demand, mg/1
TKN : Total Kjeldahal Nitrogen, mg/1,
COD : Chemical Oxygen Demand mg/1
WT : Water Temperature, Degree Celsius
TC : Total Coliform, No./100 ml
AMM : Ammonia, mg/1

TABLE 4.2: Quality of water at different location (January-December-2003).

S. No	Parameters	Water Quality Standard for 'C' Class		Monitored location		
				Palla	Nizamuddin / Bridge	Agra canel/ Okhla Barrage u/s)
1.	Ph	6.5-8.5	Min	7.39	6.83	6.82
			Max	8.64	7.96	7.82
			AV	8.04	7.41	7.37
2.	Dissolved Oxygen, Mg/I	4.0	Min	5.6	0.0	0.0
			Max	12.3	4.6	3.9
			AV	8.1	0.9	0.9
3.	Bio-chemical oxygen Demand Mg/I	3.0	Min	1	4	5
			Max	2	36	23
			AV	1	22	13
4.	Total Coliform Nos./100 ml	5000	Min	400	500000	101000
5.	Faecal Coliforms Nos./100 ml.	-	Max	4350000	890000000	262000000
			AV	427425	102508333	37522583
			Min	120	40000	20000
			Max	7000	199000000	97000000
			AV	1943	18036333	15295083

Min= Minimum, Max= Maximum, Av=Average

Sources: CPCB, 2003

Delhi generated 3300 milliion litres per day (MLD) of wastewater against the city treatment capacity for about 2300 MLD, contributing to the 79 percent pollution of the river Yamuna. The Government of NCT of Delhi has officially stated that over 200 kms of its trunk sewer system is in a state of collapse. Most of the resettlement colonies only 19 have

sewer while only 523 of the 567 unauthorized but regularized colonies have sewers. Almost all i.e. 1639 unauthorized colonies have no sewers, so this is the reason behind environmental degradation of river Yamuna.

The CPCB is regularly monitoring the Yamuna river on monthly basis in Delhi segment at three locations i.e. Palla, Nizamuddin barrage and Okhla barrage. The Delhi segment of river Yamuna is characterized by high bacterial load (except at Palla) having high BOD with strong disagreeable order. The anaerobic condition in rivers is frequently reflected by masses of gaseous sludge rising from the bottom and floating at the surface at water..In addition, monitoring of 22 drains, which are the major source of pollution in the river are also being undertaken regularly. The major reason of pollution in river Yamuna is not only discharges from domestic and industrial sources but also over-exploitation of fresh water available in the river, which is essentially required to maintain the self purification in the river. The total pollution load in terms of Biochemcial oxygen Demand carried by these 22 drains during the year 2002 is about 259.61 tonnes per day (TPD), out of which 248.67 TPD joins the river and the rest joins the canals.

Samples were also collected at different locations of River Yamuna i.e. Palla, D/s of Wazirabad, D/s of Najafgarh drain (Pontoon Pool), Kudesia Ghat, ITO Bridge, Nizamuddin Bridge, Okhla Bridge (D/S of Shahdara drain) and at Jaitpur (Agra canal). Tests results are as under:

TABLE 4.3: Date of Sampling 9.5.2011

S. No.	Location Water quality criteria ('C' Class)	pH 6.0-9.0	COD (mg/I) -	BOD (mg/I) 3(max)	DO (mg/I) 4(min)	Total coliform (MPN/100 ml) 5000	Faecal Coliform (MPN/100 ml)-
1.	River Yamuna at Palla	8.2	20	2.0	9.0	24000	15000
2.	Surghat (Down stream of Wazirabad Barrage)	7.4	36	5	7.5	90000	26000
3.	River Yamuna at Khajori Paltoon Phool (Downstream Najafgarh Drain).	7.7	328	70	Nil	19000000	7200000
4.	River Yamuna at Kudesia Ghat	7.6	128	25	Nil	21000000	260000
5.	River Yamuna at ITO Bridge	7.6	152	37	Nil	36000000	2000000
6.	River Yamuna at Nizamuddin Bridge	7.5	60	19	Nil	9000000	2100000
7.	Agra Canal (Okhla)	7.5	80	24	Nil	2600000	1900000
8.	River Yamuna after meeting Shahdara Drain (Downstream Okhla Barrage)	7.8	136	30	Nil	260000000	210000000
9.	Agra Canal (Jaitpur)	7.4	56	15	Nil	36000000	12000000

TABLE 4.4: Date of sampling 5.7.2011

S. No.	Location Water quality criteria ('C' Class)	pH 6.0-9.0	COD (mg/I)-	BOD (mg/I) 3(max)	DO (mg/I) 4(min)	Total coliform (MPN/100 ml) 5000	Faecal Coliform (MPN/100 ml)-
1.	River Yamuna at Palla	8.2	16	2.1	5.0	9400	
2.	Surghat (Down stream of Wazirabad Barrage)	8.1	28	3.0	4.0	24000	6200
3.	River Yamuna at Khajori Paltoon Phool (Downstream Najafgarh Drain).	7.4	136	25	Nil	2400000	9500
4.	River Yamuna at Kudesia Ghat	7.5	80	20	3.2	910000	30000
5.	River Yamuna at ITO Bridge	7.4	128	26	1.0	24000000	110000
6.	River Yamuna at Nizamuddin Bridge	8.0	44	13	1.8	6500000	11000000
7.	Agra Canal (Okhla)	7.2	48	14	0.8	930000	730000
8.	River Yamuna after meeting Shahdara Drain (Downstream Okhla Barrage)	7.5	128	40	Nil	240000000	4400000
9.	Agra Canal (Jaitpur)	7.1	32	11	1.0	9300000	1900000

TABLE 4.5: Date of Sampling 27.9.2011

S. No.	Location Water quality criteria ('C' Class)	pH 6.0-9.0	COD (mg/I) -	BOD (mg/I) 3(max)	DO (mg/I) 4(min)	Total coliform (MPN/100 ml) 5000	Faecal Coliform (MPN/100 ml)-
1.	River Yamuna at Palla	7.8	28	1.7	7.1	2400	1400
2.	Surghat (Down stream of Wazirabad Barrage)	8.1	20	2.0	6.7	7500	2000
3.	River Yamuna at Khajori Paltoon Phool (Downstream Najafgarh Drain).	7.5	128	40	Nil	9300	2300
4.	River Yamuna at Kudesia Ghat	7.8	44	16	1.8	110000	4300
5.	River Yamuna at ITO Bridge	7.6	120	40	1.3	12000	1500
6.	River Yamuna at Nizamuddin Bridge	7.6	48	14	3.4	91000	3600
7.	Agra Canal (Okhla)	8.1	40	12	3.1	9000	3600
8.	River Yamuna after meeting Shahdara Drain (Downstream Okhla Barrage)	7.7	152	35	0.7	1100000	24000
9.	Agra Canal (Jaitpur)	8.0	44	13	3.0	20000	7300

TABLE 4.6: Date of Sampling 1.11.2011

S. No.	Location Water quality criteria ('C' Class)	pH 6.0-9.0	COD (mg/I)-	BOD (mg/I) 3(max)	DO (mg/I) 4(min)	Total coliform (MPN/100 ml) 5000	Faecal Coliform (MPN/100 ml)-
1.	River Yamuna at Palla	7.6	22	2.3	7.1	1100	720
2.	Surghat (Down stream of Wazirabad Barrage)	7.5	36	3.8	6.8	46000	24000
3.	River Yamuna at Khajori Paltoon Phool (Downstream Najafgarh Drain).	8.0	120	31	Nil	240000	110000
4.	River Yamuna at Kudesia Ghat	7.4	60	14	Nil	110000	44000
5.	River Yamuna at ITO Bridge	7.2	148	40	Nil	240000	75000
6.	River Yamuna at Nizamuddin Bridge	7.1	40	16	Nil	27000	20000
7.	Agra Canal (Okhla)	8.0	88	25	Nil	27000	15000
8.	River Yamuna after meeting Shahdara Drain (Downstream Okhla Barrage)	7.8	124	36	Nil	240000	210000
9.	Agra Canal (Jaitpur)	7.9	80	22	Nil	150000	27000

TABLE 4.7: Date of Sampling 4.1.2012

S. No.	Location Water quality criteria ('C' Class)	pH 6.0-9.0	COD (mg/I)-	BOD (mg/I) 3(max)	DO (mg/I)4 (min)	Total coliform (MPN/100 ml) 5000	Faecal Coliform (MPN/100 ml)-
1.	River Yamuna at Palla	7.7	24	2.3	7.9	2000	1100
2.	Surghat (Down stream of Wazirabad Barrage)	8.0	40	8	8.3	15000	4300
3.	River Yamuna at Khajori Paltoon Phool (Downstream Najafgarh Drain).	7.6	356	95	Nil	110000	46000
4.	River Yamuna at Kudesia Ghat	7.9	120	26	Nil	21000	44
5.	River Yamuna at ITO Bridge	8.4	140	33	Nil	110000	29000
6.	River Yamuna at Nizamuddin Bridge	7.7	104	20	Nil	35000	27000
7.	Agra Canal (Okhla)	7.6	132	28	Nil	28000	15000
8.	River Yamuna after meeting Shahdara Drain	7.6	156	32	Nil	210000	150000
9.	Agra Canal (Jaitpur)	7.8	80	21	Nil	150000	93000

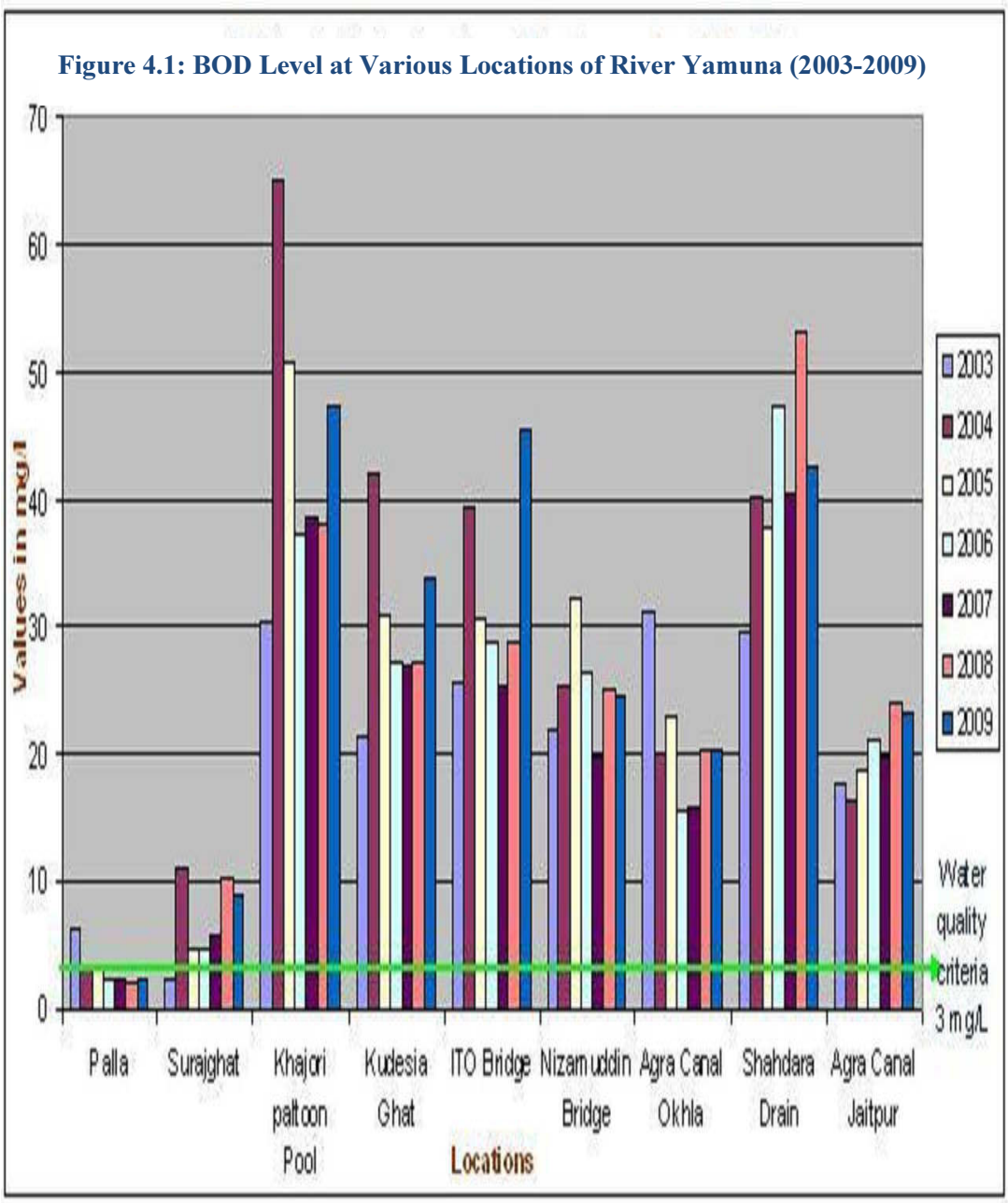
TABLE 4.8: Date of Sampling 5.3.2012

S. No	Location Water quality criteria ('C' Class)	pH 6.0-9.0	COD (mg/I)-	BOD (mg/I) 3(max)	DO (mg/I) 4(min)	Total coliform (MPN/100 ml) 5000	Faecal Coliform (MPN/100 ml)-
1.	River Yamuna at Palla	8.3	12	2.0	8.5	1500	500
2.	Surghat (Down stream of Wazirabad Barrage)	7.8	28	4.4	5.1	9100	2800
3.	River Yamuna at Khajori Paltoon Phool (Downstream Najafgarh Drain).	8.1	332	90	Nil	110000	75000
4.	River Yamuna at Kudesia Ghat	8.2	136	28	Nil	46000	21000
5.	River Yamuna at ITO Bridge	8.1	128	24	Nil	240000	110000
6.	River Yamuna at Nizamuddin Bridge	8.2	140	30	Nil	110000	46000
7.	Agra Canal (Okhla)	8.0	160	35	Nil	46000	15000
8.	River Yamuna after meeting Shahdara Drain (Downstream Okhla Barrage)	8.2	272	62	Nil	1500000	750000
9.	Agra Canal (Jaitpur)	7.9	100	30	Nil	91000	21000

TABLE 4.9: Date of Sampling 10.7.2012

S.No.	Location Water quality criteria ('C' Class)	pH 6.0-9.0	COD (mg/I) -	BOD (mg/I) 3(max)	DO (mg/I) 4(min)	Total coliform (MPN/100 ml) 5000	Faecal Coliform (MPN/100 ml)-
1.	River Yamuna at Palla	7.3	20	2	7.3	1500	300
2.	Surghat (Down stream of Wazirabad Barrage)	6.9	28	4	6.0	7500	730
3.	River Yamuna at Khajori Paltoon Phool (Downstream Najafgarh Drain).	7.2	468	140	Nil	95000	24000
4.	River Yamuna at Kudesia Ghat	7.1	120	22	Nil	36000	11000
5.	River Yamuna at ITO Bridge	7.0	128	30	Nil	210000	75000
6.	River Yamuna at Nizamuddin Bridge	7.3	84	22	Nil	91000	23000
7.	Agra Canal (Okhla)	7.1	68	17	Nil	210000	95000
8.	River Yamuna after meeting Shahdara Drain	7.0	108	32	Nil	240000	150000
9.	Agra Canal (Jaitpur)	7.2	72	14	Nil	36000	16000

Figure 4.1: BOD Level at Various Locations of River Yamuna (2003-2009)



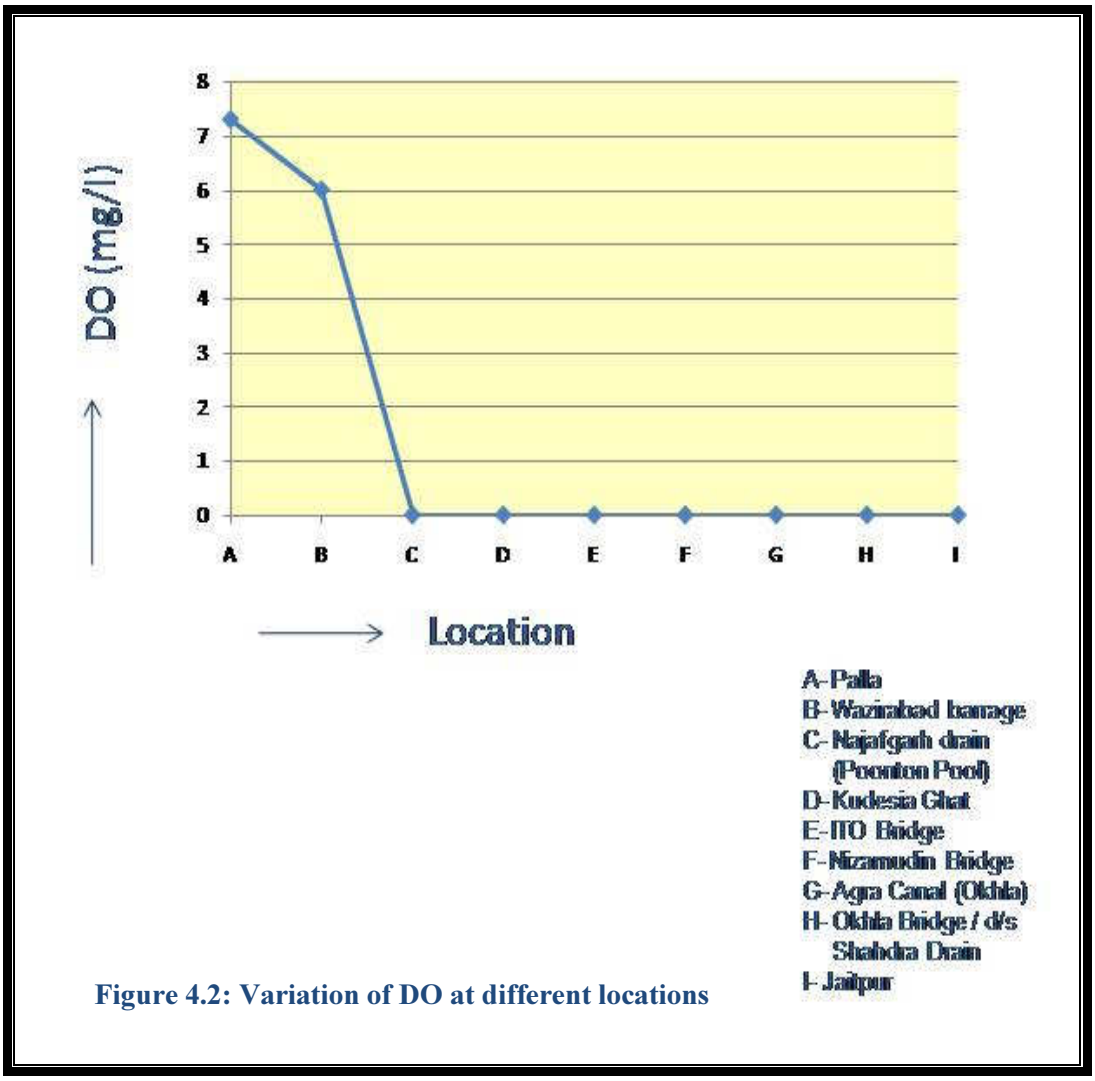


Figure 4.2: Variation of DO at different locations

A-Palla
B-Wazirabad barrage
C-Najafgarh drain (Poonton Pool)
D-Kudesia Ghat
E-ITO Bridge
F-Nizamudin Bridge
G-Agra Canal (Okhla)
H-Okhla Bridge / d/s Shahdra Drain
I-Jaitpur

Figure 4.3: Variation of BOD at different locations

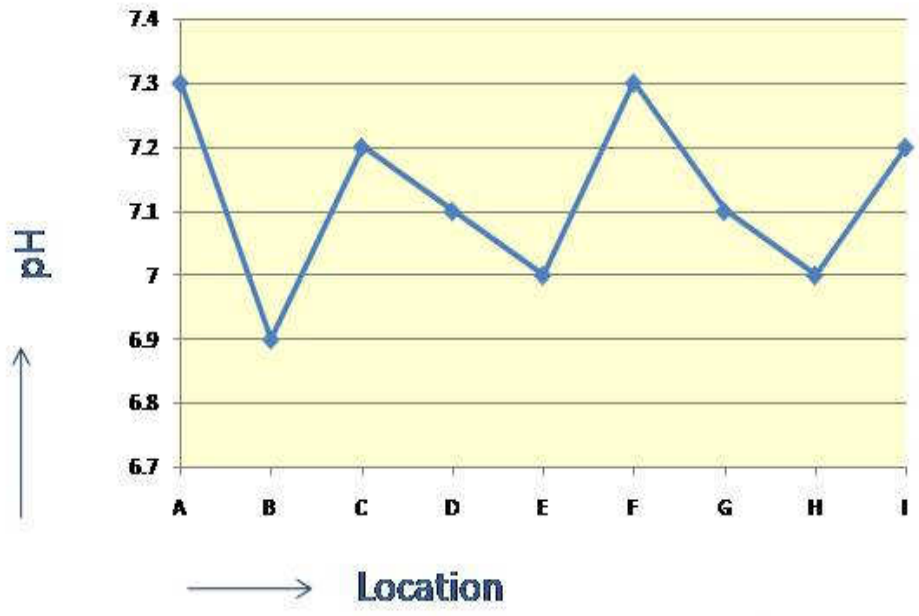


Figure 4.4: Variation of pH at different locations

A- Palla
B- Wazirabad barrage
C- Najafgarh drain (Powerton Pool)
D- Kudesia Ghat
E- ITO Bridge
F- Nizamuddin Bridge
G- Agra Canal (Okhla)
H- Okhla Bridge / d/s Shahdra Drain
I- Jaitpur

Figure 4.5: Variation of COD at different locations

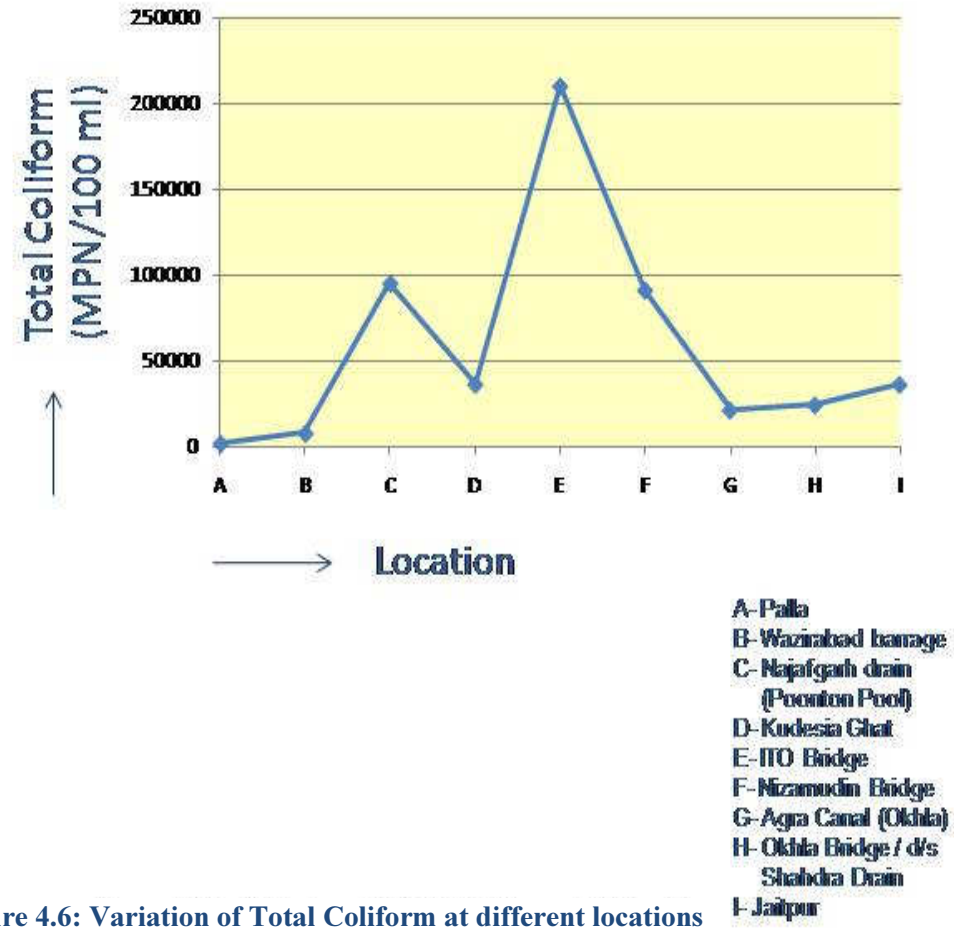


Figure 4.6: Variation of Total Coliform at different locations

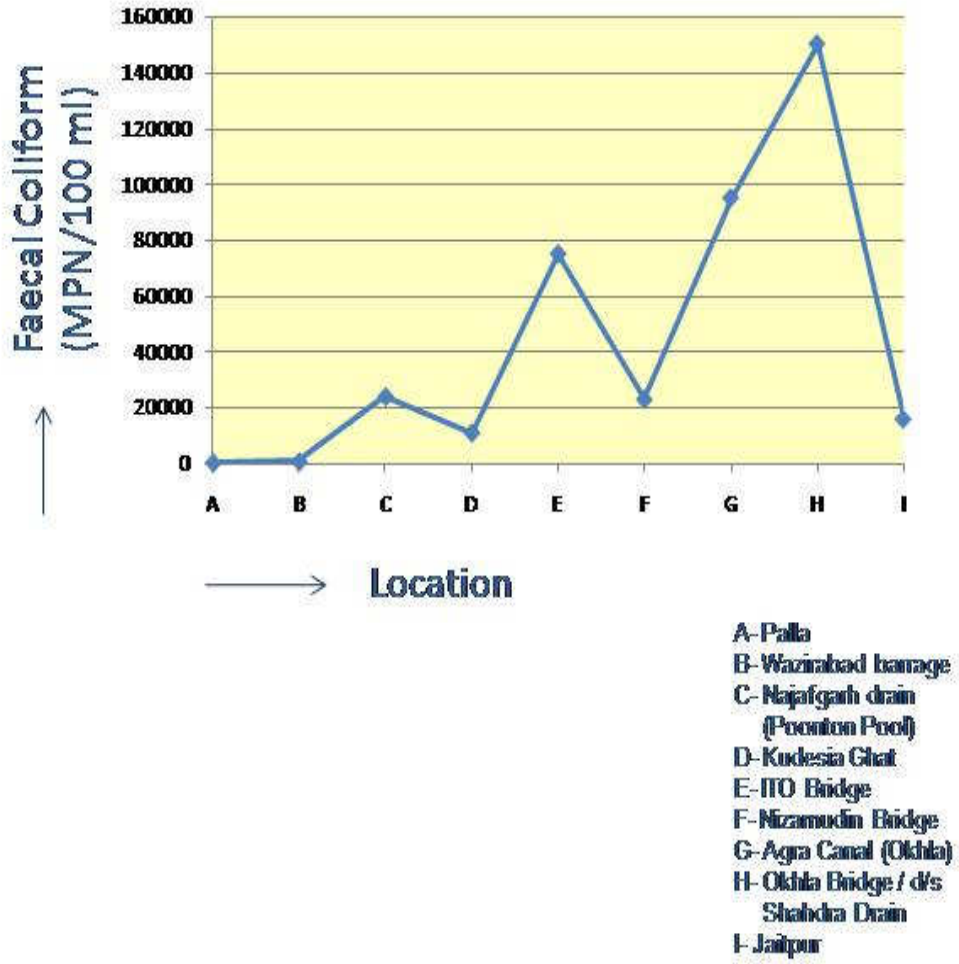


Figure 4.7: Variation of Faecal Coliform at different locations

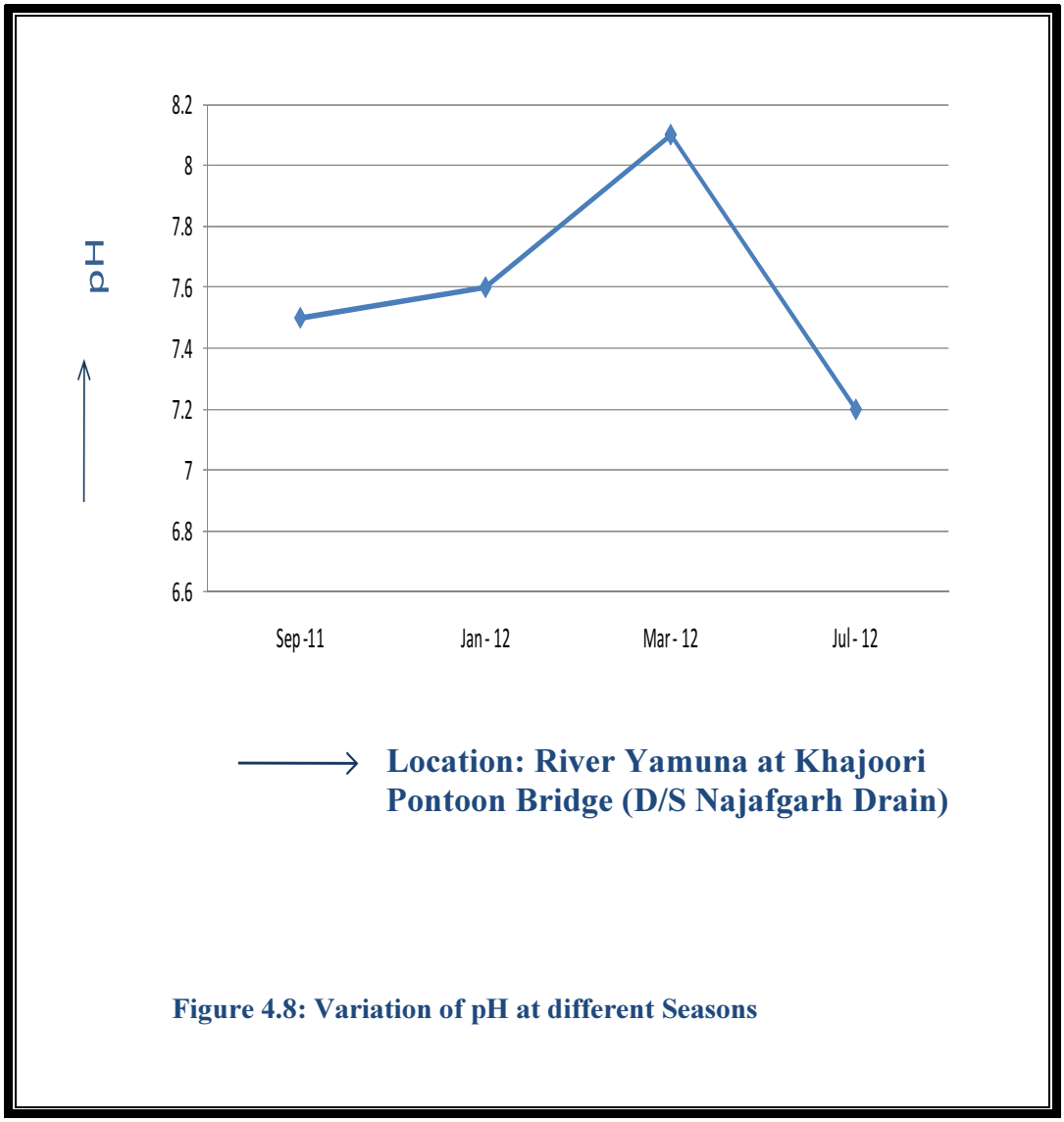


Figure 4.8: Variation of pH at different Seasons

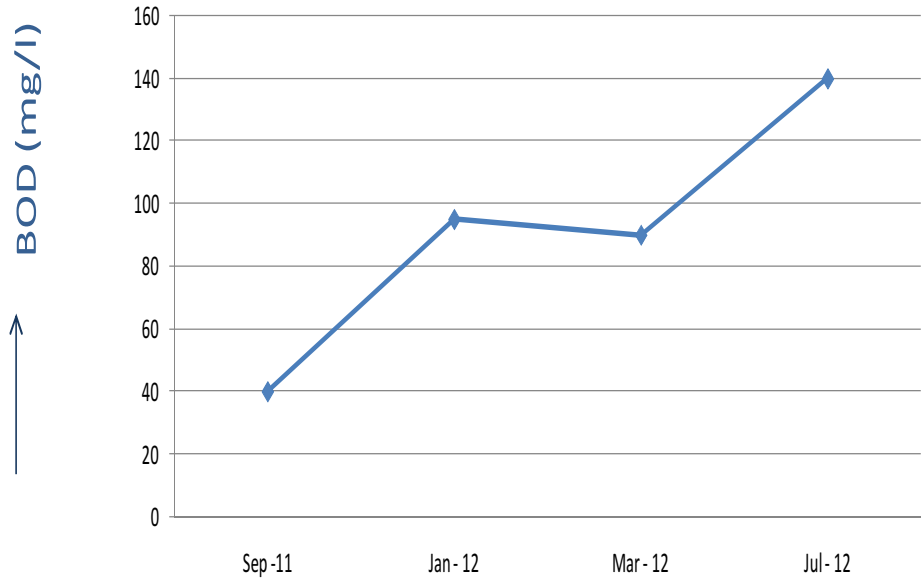


Figure 4.8: Variation of BOD at different Seasons

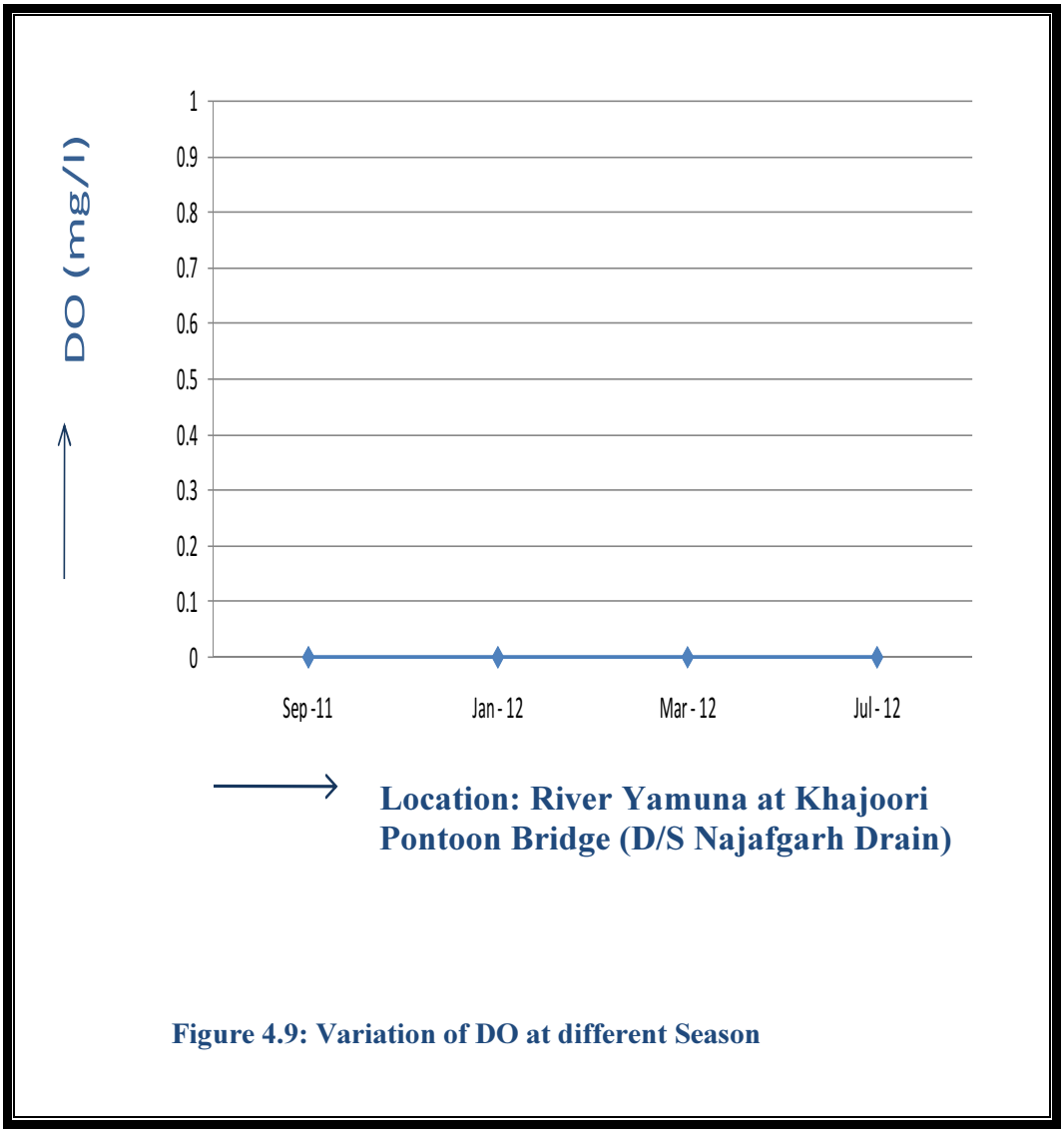


Figure 4.9: Variation of DO at different Season

4 .2 CHARACTERSTICS OF DRAINS FALLING INTO RIVER YAMUNA.

4.2.1 Characteristics of various Drains

22 drains joins River Yamuna, causing heavy pollution in terms of BOD, COD and suspended solids and involve micro pollutants, which include generally pesticides heavy metals, DDT, BHC.

Samples were collected from different drains i.e. Najafgarh drain, Magazine road drain, ISBIT drains, Civil Military drain, Power House drain, Sen Nursing Home drain, Maharani Bagh drain, Sarita Vihar drain, Tuglakhabad drain and Shahdara drain. The test results of the samples are as under:

TABLE 4.11: Date 9.5.2011

S. No	Name of Sample	pH	TSS (mg/I)	COD (mg/I)	BOD (mg/I)
	General	5.5-9.0	100	250	30
1	Najafgarh Drain	7.5	201	316	80
2	Metcalf House Drain	7.5	40	148	26
3	Khyber Pass Drain	7.3	32	84	20
4	Sweeper Colony Drain	7.3	282	264	75
5	Magazine Road Drain	7.2	412	504	165
6	ISBT Drain	7.8	106	348	85
7	Tonga Stand Drain	7.6	120	186	50

S. No	Name of Sample	pH	TSS (mg/l)	COD (mg/l)	BOD (mg/l)
8	Moat Drain	No flow	No flow	No flow	No flow
9	Civil Mill Drain	7.7	132	328	80
10	Power House Drain	7.5	188	372	105
11	Sen Nursing Home Drain	7.5	108	548	185
12	Drain No.12A	No flow	No flow	No flow	No flow
13	Drain No.14	7.6	38	64	13
14	Barapulla Drain	7.7	82	184	50
15	Maharani Bagh Drain	7.6	204	496	150
16	Kalkaji Drain	7.5	58	116	36
17	Sarita Vihar Drain (Mathura Road)	7.8	288	220	105
18	Tehkhand Drain	7.5	102	316	125
19	Tuglakabad Drain	7.5	102	144	40
20	Drain Near LPG Bottling Plant	7.6	80	288	110
21	Drain Near Sarita Vihar Bridge	7.7	82	232	80
22	Shahdra Drain	7.7	240	308	80
23	Sahibabad Drain	7.8	220	740	260
24	Indrapuri Drain	7.7	404	556	240

TABLE 4.12: Date 05.07.2011

S. no	Name of Sample	pH	TSS (mg/l)	COD (mg/l)	BOD (mg/l)
	General	5.5-9.0	100	250	30
1	Najafgarh Drain	7.5	-	284	65
2	Metcalf House Drain	7.3	-	48	14
3	Khyber Pass Drain	7.6	-	68	21
4	Sweeper Colony Drain	7.3	-	168	40
5	Magazine Road Drain	7.2	-	428	140
6	ISBT Drain	7.3	-	248	50
7	Tonga Stand Drain	7.3	-	268	80
8	Moat Drain	No flow	No Flow	No flow	No flow
9	Civil Mill Drain	No flow	No Flow	No flow	No flow
10	Power House Drain	7.1	-	408	135
11	Sen Nursing Home Drain	7.2	-	308	100
12	Drain No.12A	No flow	No Flow	No flow	No flow
13	Drain No.14	7.5	-	60	16
14	Barapulla Drain	7.5	-	168	55
15	Maharani Bagh Drain	7.2	-	308	100
16	Kalkaji Drain	7.5	-	220	70
17	Sarita Vihar Drain (Mathura Road)	7.2	-	184	60
18	Tehkhand Drain	7.6	-	160	55
19	Tuglakabad Drain	7.7	-	236	75
20	Drain Near LPG Bottling Plant	7.6	-	280	95
21	Drain Near Sarita Vihar Bridge	7.3	-	152	48
22	Shahdra Drain	7.3	-	248	80
23	Sahibabad Drain	7.1	-	660	210
24	Indrapuri Drain	7.2	-	488	130

TABLE 4.13: Date 27.9.2011

S. No	Name of Sample	pH	TSS (mg/I)	COD (mg/I)	BOD (mg/I)
	General	5.5-9.0	100	250	30
1	Najafgarh Drain	7.8	232	248	80
2	Metcalf House Drain	7.4	48	80	16
3	Khyber Pass Drain	7.7	40	68	15
4	Sweeper Colony Drain	7.4	56	128	32
5	Magazine Road Drain	7.5	272	488	160
6	ISBT Drain	7.4	80	124	40
7	Tonga Stand Drain	7.6	168	132	50
8	Moat Drain	No flow	No flow	No flow	No flow
9	Civil Mill Drain	7.5	120	284	90
10	Power House Drain	7.3	228	280	80
11	Sen Nursing Home Drain	7.3	120	280	85
12	Drain No.12A	No flow	No flow	No flow	No flow
13	Drain No.14	7.5	28	64	12
14	Barapulla Drain	7.8	368	140	46
15	Maharani Bagh Drain	7.6	84	188	60
16	Kalkaji Drain	7.6	58	60	17
17	Sarita Vihar Drain (Mathura Road)	8.0	160	228	75
18	Tehkhand Drain	7.5	192	248	80
19	Tuglakabad Drain	7.8	62	108	32
20	Drain Near LPG Bottling Plant	7.9	236	168	56
21	Drain Near Sarita Vihar Bridge	7.7	44	80	26
22	Shahdra Drain	7.8	70	160	50
23	Sahibabad Drain	7.6	500	608	180
24	Indrapuri Drain	7.5	136	200	155

TABLE 4.14: Date 1.11.2011

S .No	Name of Sample	pH	TSS (mg/l)	COD (mg/l)	BOD (mg/l)
	General	5.5-9.0	100	250	30
1	Najafgarh Drain	7.6	194	260	30
2	Metcalf House Drain	7.3	24	108	75
3	Khyber Pass Drain	7.4	55	72	18
4	Sweeper Colony Drain	7.4	60	92	17
5	Magazine Road Drain	7.1	228	510	24
6	ISBT Drain	7.1	84	256	175
7	Tonga Stand Drain	7.5	170	320	75
8	Moat Drain	No flow	No flow	No flow	No flow
9	Civil Mill Drain	7.7	290	380	140
10	Power House Drain	7.5	194	333	110
11	Sen Nursing Home Drain	7.4	278	392	160
12	Drain No.12A	No flow	No flow	No flow	No flow
13	Drain No.14	7.5	40	68	19
14	Barapulla Drain	7.3	84	120	48
15	Maharani Bagh Drain	7.4	50	295	59
16	Kalkaji Drain	7.3	42	72	22
17	Sarita Vihar Drain (Mathura Road)	7.4	474	268	85
18	Tehkhand Drain	7.3	184	140	82
19	Tuglakabad Drain	7.8	268	232	48
20	Drain Near LPG Bottling Plant	7.9	110	292	50
21	Drain Near Sarita Vihar Bridge	7.7	70	152	34
22	Shahdra Drain	7.7	252	256	48
23	Sahibabad Drain	7.8	512	624	180
24	Indrapuri Drain	7.5	140	492	150

TABLE 4.15: Date 4.1.2012

S. No	Name of Sample	pH	TSS (mg/I)	COD (mg/I)	BOD (mg/I)
	General	5.5-9.0	100	250	30
1	Najafgarh Drain	7.4	316	232	70
2	Metcalf House Drain	7.7	60	100	33
3	Khyber Pass Drain	7.9	12	40	5
4	Sweeper Colony Drain	7.7	26	100	25
5	Magazine Road Drain	7.5	456	512	170
6	ISBT Drain	7.9	168	308	95
7	Tonga Stand Drain	7.6	244	200	70
8	Moat Drain	No flow	No flow	No flow	No flow
9	Civil Mill Drain	7.8	276	380	135
10	Power House Drain	7.7	204	244	75
11	Sen Nursing Home Drain	7.7	452	364	120
12	Drain No.12A	No flow	No flow	No flow	No flow
13	Drain No.14	7.9	16	60	8
14	Barapulla Drain	7.6	148	120	35
15	Maharani Bagh Drain	7.4	240	288	90
16	Kalkaji Drain	7.5	38	80	25
17	Sarita Vihar Drain (Mathura Road)	7.5	444	304	140
18	Tehkhand Drain	7.5	88	320	125
19	Tuglakabad Drain	7.6	304	208	90
20	Drain Near LPG Bottling Plant	7.7	120	368	145
21	Drain Near Sarita Vihar Bridge	7.6	116	308	80
22	Shahdra Drain	7.5	292	444	110
23	Sahibabad Drain	7.4	376	672	220
24	Indrapuri Drain	7.3	188	240	120

TABLE 4.16: Date 5.3.2012

S. No	Name of Sample	pH	TSS (mg/I)	COD (mg/I)	BOD (mg/I)
	General	5.5-9.0	100	250	30
1	Najafgarh Drain	8.1	204	220	65
2	Metcalf House Drain	7.9	54	120	31
3	Khyber Pass Drain	8.4	22	40	10
4	Sweeper Colony Drain	7.7	26	100	22
5	Magazine Road Drain	8.0	316	364	115
6	ISBT Drain	8.0	40	180	50
7	Tonga Stand Drain	8.0	304	360	110
8	Moat Drain	No flow	No flow	No flow	No flow
9	Civil Mill Drain	7.6	368	472	160
10	Power House Drain	7.8	144	304	85
11	Sen Nursing Home Drain	7.9	576	340	95
12	Drain No.12A	No flow	No flow	No flow	No flow
13	Drain No.14	8.4	34	72	16
14	Barapulla Drain	7.5	208	260	80
15	Maharani Bagh Drain	7.9	276	376	105
16	Kalkaji Drain	7.9	26	36	4
17	Sarita Vihar Drain (Mathura Road)	7.4	484	596	165
18	Tehkhand Drain	7.9	512	584	230
19	Tuglakabad Drain	8.0	352	200	80
20	Drain Near LPG Bottling Plant	8.0	106	200	85
21	Drain Near Sarita Vihar Bridge	8.2	78	152	56
22	Shahdra Drain	8.2	504	272	62
23	Sahibabad Drain	7.8	608	624	250
24	Indrapuri Drain	8.1	280	456	155

TABLE 4.17: Date 10.7.2012

S. No	Name of Sample	pH	TSS (mg/I)	COD (mg/I)	BOD (mg/I)
	General	5.5-9.0	100	250	30
1	Najafgarh Drain	7.0	228	388	85
2	Metcalf House Drain	7.0	30	80	23
3	Khyber Pass Drain	7.1	8	40	6.6
4	Sweeper Colony Drain	6.6	30	76	25
5	Magazine Road Drain	6.8	148	380	90
6	ISBT Drain	7.1	104	460	155
7	Tonga Stand Drain	7.0	176	452	165
8	Moat Drain	No flow	No flow	No flow	No flow
9	Civil Mill Drain	6.8	156	520	175
10	Power House Drain	7.0	128	356	115
11	Sen Nursing Home Drain	6.9	404	380	135
12	Drain No.12A	No flow	No flow	No flow	No flow
13	Drain No.14	7.2	34	96	14.9
14	Barapulla Drain	7.1	58	176	68
15	Maharani Bagh Drain	7.0	220	376	110
16	Kalkaji Drain	No flow	No flow	No flow	No flow
17	Sarita Vihar Drain (Mathura Road)	7.0	420	510	205
18	Tehkhand Drain	7.2	210	264	85
19	Tuglakabad Drain	7 . 1	452	328	115
20	Drain Near LPG Bottling Plant	7.0	76	244	75
21	Drain Near Sarita Vihar Bridge	7.1	102	136	46
22	Shahdra Drain	6.9	284	240	95
23	Sahibabad Drain	6.8	620	840	190
24	Indrapuri Drain	6.8	360	520	150

CHAPTER 5
CONTROL MEASURES FOR POLLUTION OF RIVER YAMUNA

5.1 POLLUTION POTENTIAL IN THE YAMUNA BASIN.

The entire stretch of Yamuna River right from its origin to confluence with the Ganga and its tributaries is greatly influenced both in terms of quality and quantity because of human activities. Yamuna enters Delhi at Palla village 15 Km upstream of Wazirabad barrage, which acts as a reservoir for Delhi. Delhi generates about 3300 million litre per day (mld) of sewage, against an installed waste water treatment capacity of 2300 MLD. Thus, about 1000 MLD of untreated and a significant amount of partially treated sewage enter the river everyday. The Wazirabad barrage lets out very little water into the river. In summer months especially, the only flow downstream of Wazirabad is of industrial and sewage effluents. Lesser discharge means lesser river flow and thus, greater levels of pollution. From the Okhla barrage, which is the exit point for the river in Delhi, the Agra Canal branches out from Yamuna. During the dry months, almost no water is released from this barrage to downstream Yamuna. Instead, discharge from Shahdara drain joins the river downstream of the barrage, bringing effluents from east Delhi and Noida into the river. This is the second largest polluter of the river after the Najafgarh drain.

The main problem lies in undetected and untreated pesticide residues. Water works officials in Delhi and Agra point out that pesticide traces cannot be removed with conventional treatment. “Organic

substance can be assimilated in freshwater, provided there is enough freshwater in the river", states R Dalwani, scientist, ministry of environment and forests (MEF). But for micro pollutants such as pesticides, only more freshwater can reduce the percentage of trace in water. These cannot be dissolved or assimilated, but certainly can be diluted to an extent. The river has a dilution requirement of 75 per cent, which implies that for every 100 liters of wastewater, 75 liters of freshwater is required. Scientists state that with the flow of water, pollutants (especially organic pollutants) degrade to a large extent. But at every step, this purified water is abstracted, and ever larger loads of pollution make their way into the river.

The pollution potential in the catchments area depends on various human activities and categorized into groups:

5.1.1 Point Source of Pollution

The point sources of pollution are contributed at a single point in significant amount such as wastewater drain joining a water body. The point source pollution covers two major categories. Domestic pollution & Industrial Pollution.

5.1.2 Domestic Pollution

Sewage is discharged in to the river without any treatment from the cities located along the banks of river and its tributaries. This affects aquatic life and depletes oxygen level resulting in to bad odors and turbidity. The river water does not remain suitable due to pollution, for

uses like drinking, outdoor bathing, propagation of aquatic life, irrigation and industrial purpose.

5.1.3 Industrial Pollution

Industrial pollution affects dissolved oxygen, temperature & pH etc. Some industrial effluents cause toxicity. Large and medium industrial unit-22 in Haryana, 42 in Delhi and 17 in Uttar Pradesh have been identified as directly discharging and polluting the river Yamuna under the Action Plan area. These industries include paper, sugar, chemical, leather, distillery and pharmaceuticals etc. These industries are contemplated to adopt adequate pollution control measures under the existing environment laws to ensure that treated effluent confirming the prescribed standards should only be discharged in to river.

5.1.4 Diffused Sources of Pollutions

The diffused pollutions originate mainly from the catchments area through movement of water. Pollutants originated from the top soil losses, includes soil organic matter, plants residue, nutrient elements, organic chemicals, toxic elements and bacteria.

5.2 Pollution in Yamuna due to improper sewerage system and non-functioning of STPs

For the purposes of sewerage and drainage Delhi can be divided into six zones 1) Rithila, 2) Coronation pillar, 3) Keshopur, 4) Okhla, 5) Trans Yamuna and 6) Outer Delhi. Besides this, there are newly

developed areas or urban extensions such as Narela, Pappan Kalan, Najafgarh,Vasant kunj, Mehrauli, Sarita Vihar. The sewerage is provided in planned colonies, unauthorised/regularised colonies, resettlement colonies and urban villages but no sewer facilities exist in most of the rural areas, unauthorised colonies, slums and JJ clusters. The untreated sewage from these areas goes into the various drains and finally falls into the river Yamuna, thereby increasing the pollution load in the holy river.

As per the report of Central Pollution Control Board, about 3267 mld of waste water is generated in Delhi including 218 mld from industrial sources. There are 30 STPs located at 17 locations in Delhi. Out of these 30 STPs, 20 are running under capacity, 5 are running over capacity, 3 are non-functional and 2 are running to their capacity . Most of the STPs are based on activated sludge process. They do not perform satisfactorily due to operational problems. Out of these 30 STPs (Ghitorni, Rohini and Keshopur-1) are not found in operation. The total treatment capacity of all the STPs was observed as 2330 mld. The actual treatment of sewage was found only 1478 mld (about 45% of total sewage generated). Thus the remaining untreated/partially treated sewage pollutes the river Yamuna.

The existing capacity of treatment plants is under utilized due to deficiency in the collection system and chocking of existing sewerage, failure of pump connections and trunk sewers, internal sewers and peripheral sewers. The large network of peripheral sewers is very old and some of them are under sized and also in damaged condition. Delhi Jal Board must take immediate steps for improving the sewerage system.

The non functional STPs must be brought to work at their optimal capacity. Also new STPs must be installed at the appropriate locations so that proper treatment can be given to the waste waters and untreated waste is not allowed to go into the river Yamuna to keep it pollution free.

5.3 SIGNIFICANT FACTS REGARDING POLLUTION IN RIVER YAMUNA

5.3.1 The Yamuna River bed in Delhi is right now only being used as a canal to transport Delhi's sewage to Agra Canal.

As per report of Central Pollution Control Board "At Wazirabad the river is trapped again through a barrage for drinking water supply to urban aglameration at Delhi. From Wazirabad barrage **no water is allowed to flow down** particularly during summer, as the available water in the river is not adequate to fulfill the water supply demand of Delhi. The water flows in the Yamuna River downstream of Wazirabad is the treated, partially treated or untreated domestic & industrial wastewater contributed by various drains joining river Yamuna and canal water". **After 22 km downstream from Wazirabad barrage the Yamuna water is again blocked and diverted into Agra Canal for irrigation through another barrage at Okhla.** Similar to downstream of Wazirabad, at downstream Okhla barrage the water flows in the river is the drain water of domestic & industrial origin contributed mainly by Shahdara drain.

In the public interest petition case titled Cdr Sureshwar D Sinha Vs. Union of India W.P.(C)537 of 1992, the Supreme Court recognized

High powered committee put forward various short term & Long term measures. Among them were the follows:

Since the availability of even 10 cumecs of fresh water in the river particularly along Delhi will not be adequate for the purpose of dilution of treated waste water to bring its BOD down to the desired level, **construction of sewerage system along the Delhi stretch of the river (between Wazirabad and Okhla) to carry the treated waste water up to Okhla for irrigation purposes is necessary.** From Okhla, the treated sewage water could be entirely diverted for irrigation through the existing canal system.

For this purpose, a quick survey and investigation may be undertaken by the Government of Delhi to assess the feasibility and cost of such a treated sewage water diversion system. This exercise should be completed by the Delhi Government in time bound manner by engaging a team of professional consultants.

Chairman indicated that once the cost estimates were available, it should be possible for National Capital Territory of Delhi to find funds for implementation of this project from its plan out lay over a period of two years.

The canal meant to divert sewage of Delhi to Agra Canal (and not use Yamuna Bed for it as it is doing now) is **simply missing**. As a result the near pondage of sewage waters between the Wazirabad and the Okhla Barrage for almost 9 months of the year results on one hand in creation of

a delusion of the river still being in place in the city but on the other results in avoidable pollution of ground water with toxic elements.

5.3.2 Spiritual & Cultural Values attached to River Yamuna are being eroded.

It has been mentioned in a CPCB report that most of the rivers including River Yamuna are spiritually regarded as mother. People from all over the country visit various stretches of this river especially at Yamunotri, Paonta Sahib, Mathura-Vrindavan and Bateshwar to take holy dip in river water to purge away their sins. Thus, the river portrays Indian culture and traditions. Deteriorated water quality and quantity of Yamuna River hurts the sentiments of Indian masses besides having several adverse impacts on life process in the river.

Yamuna river is losing its aesthetic value, glory due to severe odour that releases to the surrounding environment from the anaerobic activities occurring in the river strata and the ugly surface look contributed by blackish water, floating of garbage, plastic bags, dead bodies of animals. The religious activities and tourism are greatly affected because of these transformed characteristics of river water.

FIGURE 5.1: Immersion of Idols in River Yamuna

FIGURE 5.2: Najafgarh drain Swirl under a bridge on the way to River Yamuna

FIGURE 5.3: Najafgarh drain's polluted water entering River Yamuna

FIGURE 5.4: Formation of Foam due to oily substances & chemicals

FIGURE 5.5: Washing of clothes in River Yamuna

FIGURE 5.6: Pollution in River Yamuna at Okhla Barrage

FIGURE 5.7: A Polluted drain falling in to River Yamuna

FIGURE 5.8: Thousands of fishes dying in Polluted River Yamuna water

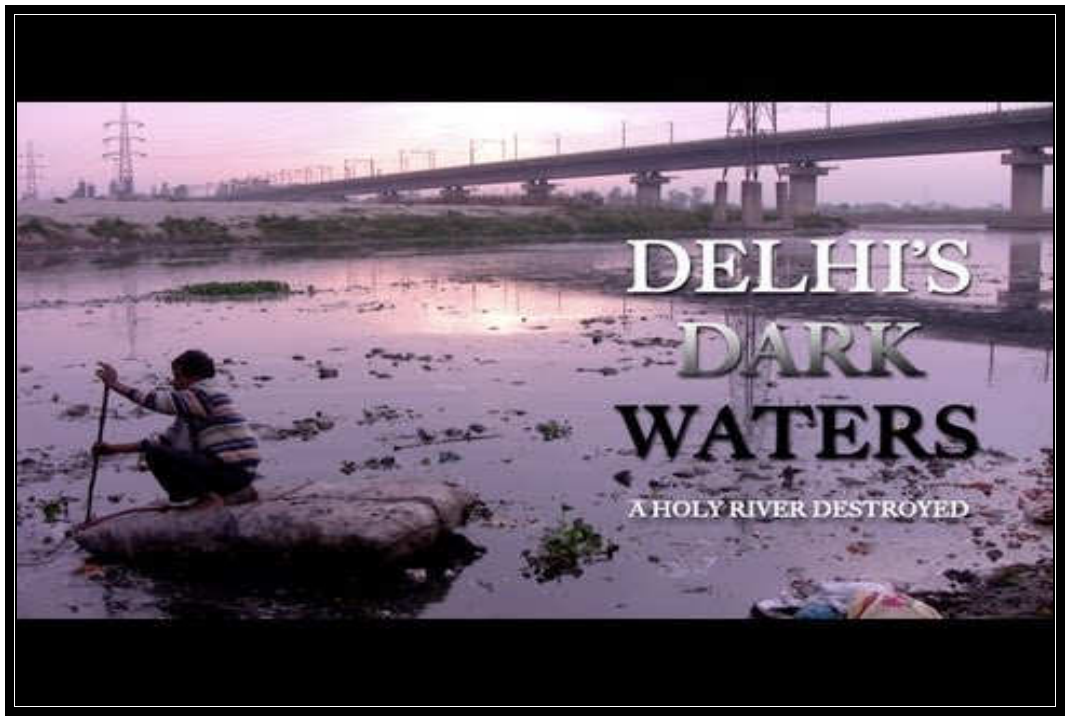


FIGURE 5.9: Delhi's Dark Waters: A Holy river destroyed

FIGURE 5.10: Clean Yamuna Campaign

5.4 PROPOSED REMEDIAL MEASURES

5.4.1 Maintenance of minimum ecological flow.

One of the main reasons of pollution of river Yamuna is the non-availability of the minimum desirable flow in the river. In order to assess the problem created by non-availability of minimum flow and to suggest remedial measures, a High Powered Committee under the Chairmanship of Member (Environment) Planning Commission was set up. The chief Secretaries of Delhi, Haryana, Himachal Pradesh, Rajasthan and UP are the Members of this Committee. The committee is required to carry out the following tasks:-

(a) To assess the requirement of a minimum flow in the river Yamuna to facilitate restoration of the desired river water quality.

(b) To suggest remedial measures for maintaining the minimum flow in the river.

(c) The High Powered Committee (HPC) has had four meetings and suggested a number of measures to be taken up on short-term and long term basis in order to maintain a minimum flow of 10 cumecs in river Yamuna for maintenance of river ecology.

(d) The spirit of the Supreme Court High Powered committee measure of maintaining 10 cumecs on its river bed throughout is not visibly fruitful yet. Most of Yamuna's river bed remains dry for months. The provisions made for 10 Cumecs of natural fresh water to be maintained throughout simply are not yielding result.

(e) In a recent order the Allahabad High Court (dated January 12, 2011 in PIL no.4003 of 2006 in the matter of Ganga Pollution Vs. State of UP and Others) has said that from any river, not more than 50% of available water should be diverted and rest should be allowed to remain in the river. This principal needs to be applied in case of Yamuna at every location, but particularly at the Hathnikund barrage.

It is abundantly clear that all current measures by Central Government, State governments have not brought back to life River Yamuna. Even the Supreme Court measures vide its High Powered Committee has not been able to restore the minimum ecological flow of the river as many evidences have been pointed out earlier. The river ends at Hathini Kund Barrage and what flows beyond Delhi is only Sewage.

The Government must strictly ensure Constant Adequate Natural Flow of Fresh Waters on the entire River Bed. The implementation should be carried out in spirit. The Fresh Natural Waters of the River should be physically present and should effectively ensure the vital ecological flow of the river throughout its stretch.

5.4.2 Construction of Parallel Sewerage Canal along the Delhi stretch of the river Yamuna (between Wazirabad barrage & Okhla barrage) to carry the treated waste water up to Okhla for irrigation purpose.

At present the Delhi stretch of Yamuna riverbed is only being used to transport sewage to Agra Canal. The proposed canal shall receive all the treated/ untreated sewage and further transport it to Agra Canal (as is already being done but using Yamuna bed).

Building the Parallel canal was another decision of the High Powered Committee as a short term measure. However, it is pointed out that in one of the HPC meeting the Delhi Government has shown financial constraints regarding its implementation which is not appreciable as much larger amounts of money have already been spent on various other infrastructure projects of lesser importance.

The proposed parallel trunk sewer/canal shall serve following purposes:

a) It shall allow the River bed of River yamuna to remain free to all pollution, all year round. When a Basic Ecological Flow is allowed to flow on its bed, it shall flow free of most contaminations that are now poured into it. Additionally, the canal shall also drastically lower the amount of Natural Fresh Water Flow required to maintain the Ecological balance of the River as there will be little need for dilution.

b) As the proposed trunk sewer/canal shall be lined (non-porous); there shall be no seepage of sewage on either sides of the River. Hence, the soil and ground waters on either side shall remain free of the deadly sewage cocktail that consistently contaminates them. Currently, the porous banks allow a recharge of groundwater (in this case by deadly poisonous sewage) for long distances. The canal shall ensure that all treated sewage flows directly into the Agra Canal and does not seep into the capital's ground water or spoil.

5.4.3 Better water management.

According to some Critical Observations of Shri Himanshu Thakkar-South Asia Network on Dams, Rivers & People there is a huge scope in curtailing unjustified water use in the Yamuna basin. Agriculture is the biggest user of water and within agriculture, paddy (rice) is the most water intensive crop. Firstly, it is not an appropriate crop for the Yamuna basin considering the water, rainfall and groundwater situation here. For example the opening lines of the official website of Department of Agriculture, Government of Haryana, states "Haryana is located in the northwest part of the country and the climate is arid to semi arid with average rainfall of 455 mm". An arid/semi arid state with annual average rainfall of 455 mm is clearly not a suitable place for water intensive crop like Paddy which requires more than 1200 mm of water for a single crop.

The Prime Minister of India, in his address to the First Core Group of Central Ministers and State Chief Ministers on prices of Essential Commodities on April 8, 2010 emphasized that Punjab and Haryana farmers needs to take up rice under SRI cultivation in right earnest when he said, "Punjab and Haryana farmers showed the way in adopting intensive, HYV based agriculture some forty year ago. They have to do it again through reduced water use, through better agronomic practice like the System of Rice Intensification method of rice cultivation".

There is also similar scope for curbing water demands in urban areas through rainwater harvesting, treatment, recyle, protection of local water systems, ground water recharge and so on. In fact groundwater aquifers can be used for water storage, as has been recommended by the

National Water Mission under PM's National Action Plan on Climate Change. Similarly protection of forests and wetlands in the Yamuna catchment, creation of more local water bodies, protection of the flood plan, etc. can all be used as a package to reduce the demand and provide supply side option.

5.4.4. Stop Shahdara Drain, Hindon Cut and other drains to flow into Yamuna and redirect them for irrigation or other uses.

No economically feasible technology being used by STPs in India can bring down the BOD level to the prescribed limit of 3 mg/l (cpcb standard for bathing quality in water bodies). Redirect city's wastewater (treated/ untreated) away from the river into STPs and use it for irrigation purposes, from all the other major cities on Yamuna.

5.4.5. Optimum utilization of existing treatment facilities of sewage treatment plants in Delhi and setting up of new S.T.P.s.

Since the operations of all STPs have been handed over to Local body (DJB) there is little or no interest in running them, leave alone running them efficiently. Lack of Funds, inconsistent electricity, heavy power bills, pilferage of diesel for electricity generators, all add up to little or no functioning of these STPs entrusted to local governing bodies. The Central Government on the lines of National Highway Authority of India (NHAI) should create a central body which takes over the functioning of all Sewage Pumping and Treatment in all of India and directly manage and fund them.

All the above measures among others shall surely help bring Back River yamuna to the people of India. Yamuna is as old as India is old. It has already existed forever. No development can last longer than forever. As part of a timeless civilization, the river Yamuna, other than being traditional water resources, is also a cultural icon and is worshipped as a goddess in Indian Culture. A little inquiry into ancient Indian scriptures, rituals, art forms, traditional vocation, festivities or even the National Anthem shall vividly bring forward the esteem and glory that this Grand River holds, even in present times.

5.5 RECENT INITIATIVES TAKEN BY DELHI GOVT.

5.5.1. Laying of Interceptor Sewerage System along Najafgarh, Supplementary & Shahdara Drains.

At present, treated effluent from the STPs is discharged into open drains that finally discharge into River Yamuna. These drains, on their way, collect the untreated waste from large parts of the city, where sewerage network is not yet laid. The sewage finds its way into the open drains and finally flows to River Yamuna through larger drains. This mixing of untreated sewage with treated effluents negates the pollution-control efforts. For reduction of Pollution in River Yamuna, DJB evolved a new concept of "Interceptor Sewer" alongwith the three major drains to check untreated sewage from flowing in to the Yamuna. Salient features of the project are:

(i) Laying of interceptor sewers in length of around 50 kms along with major drains of Irrigation & Floor Control Department {i.e.

Najafgarh (25 km), Supplementary (15 km) and Shahdara (10 km)} to intercept sewage flowing in their subsidiary small drains and conveying to the nearest Sewage Treatment Plants for treatment to ensure that only treated sewage is discharged into drains. Cost of this project is Rs.1800 cr.

(ii) Augmentation of the existing capacity of Sewage Treatment Plants at the mouth of Delhi Gate drain and Dr. Sen Nursing Home Drain constructed as Pilot plants under YAP-I from existing 2.2. MGD to 15 MGD at each plants.

(iii) Intercepting 13 small drains into Bela Road and Ring Road Trunk sewer after rehabilitation.

(iv) Construction of additional Sewerage Treatment Plants after utilization of full capacity of existing plants i.e. up-gradation of existing S.T.P at Okhla and Keshopur.

5.5.2. Advantages of the Interceptor Sewerage System

a) Both the river as well as the major drains would be protected and would not carry any untreated effluent.

b) There would be no duplication of effort regarding treatment of effluent as would be the case if STPs were set up at the mouth of the drain.

c) The sewage from more than 1500 unauthorized colonies and other unsewered areas, including rural village and JJ Clusters would be trapped before it is permitted to reach all the major drains. This

would be important in the context of statistical factor that otherwise it would take several years to sewer these unauthorized colonies. The interceptor sewers would be completely independent and neutral to the time frame within which unauthorized colonies will be sewered.

d) Since new STPs would only be put up after the capacity of the existing underutilized STPs is fully utilized, it would have a positive impact on the cost factor also.

e) As against an STP creation capacity required for the STPs at the mouth of the drain concept, the interceptor sewer concept would need only two or three additional STPs in the course of the next 2-3 years.

f) The successful implementation of this project would ensure that the three major drains, which account for 75% of the pollution problem, receive only treated effluent and, therefore, the quality of water entering the river will improve and hence, there shall be less pollution load in the receiving waters of the River Yamuna.

CHAPTER 6
CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSIONS

Based on the study the following conclusions are made:

1. The analysis of data regarding various parameters exhibits the pollution load in river Yamuna at Delhi. Except for pH & TDS, all the parameters are crossing the standard limits.

2. The bio-chemical oxygen demand (B.O.D.), Dissolved Oxygen (D.O.) & Total Coliforms are indication of organic pollution which exhibit whether water can sustain aquatic life and the presence of harmful bacteria / virus. As per the standards for class 'C' Water, the maximum permissible B.O.D is 3mg/l, the D.O. should be 4mg/l or more and the Total Coliforms should not exceed 5000 per 100ml. Analysis of data shows that B.O.D, DO & Total Coliforms were found crossing the permissible limits. Almost all the parameters were found within the permissible limits when the River enters Delhi at Palla Village. But after merging of the Najafgarh Drain into the River till its exit at near Okhla, the B.O.D., C.O.D & Total Coliforms were found much higher than the prescribed limits. The most alarming finding of the study is that there is **'Nil'** Dissolved Oxygen downstream of the River (in the lean period) beyond Wazirabad Barrage till the exit of the River from Delhi.

3. 22 drains are discharging untreated / partially treated sewage into the River Yamuna thereby increasing the pollution load manifold. The study shows that there are three major drains namely Najafgarh

Drain, Shahdara Drain and Supplementary Drain that are heavily polluting the River Yamuna (about 75% of the total pollution load in River Yamuna).

4. It is revealed during the study that there is practically no fresh water flow in the River Yamuna downstream of the Wazirabad Barrage. What flows downstream after the Wazirabad Barrage is only the untreated / partially treated sewage either falling directly or through the 22 drains into the River.

5. The Sewage Treatment Plants (STPs) are not functioning properly. Some of them are totally defunct and a very few are working that too well below their designed capacity. The unauthorized colonies, Slums & J.J. clusters do not have any sewerage facility and the sewage from these areas goes into the various drains, which finally falls untreated into the River thereby increasing the pollution load.

6. Further, it has been observed that there is a tendency of throwing the puja materials and also immersion of idols directly into the River and dumping of garbage along the drains which ultimately flow into the River, which in turn also adds to the pollution level of the River.

6.2 RECOMMENDATIONS

On the basis of analysis of the data, following recommendations are made:-

1. The untreated/partially treated sewage is required to be trapped for proper treatment and only then it should be allowed to join the drain/river. The sewerage facilities should be provided in unauthorized colonies and other unsewered areas. The dumping of

solid waste in the Drains/River should be prevented. Stringent actions are required to be taken by the concerned authorities against the defaulters and if need be more strict laws including imposition of heavy penalty are required to be made to save "RIVER YAMUNA".

2. Minimum ecological flow must be maintained in the River so that minimum dilution water is available. As reported by the High Powered Committee under the Chairmanship of Member (Env.) a minimum flow of 10cumecs is necessary for maintaining the ecological balance of the River.

3. The existing sewage treatments plants should be made functional at optimal capacity and new STPs have to be installed at appropriate locations. The waste water should only be discharged into the River after proper degree of treatment.

4. Careful planning for the development of industrial areas based on environmental impact assessment is necessary to control industrial pollution. All the small-scale industries should be connected with the Combined Effluent Treatment Plants (CETPs), which should also be made functional at their optimal level and the industrial waste must be discharged into the River only after proper treatment.

5. Construction of parallel sewerage canal along the Delhi stretch of River Yamuna should be undertaken to carry the treated waste water / sewage upto Okhla for irrigation purpose. This move shall allow the river bed to remain free of pollution / ground water contamination.

6. Disposal of garbage, solid, semi-solid waste into river, its tributaries and drains should be restricted.
7. Keeping in view the very high coliform microorganism count tertiary treatment should be made mandatory before discharge into river.
8. Efforts are required to be made to aerate the river water by installing fountains on the banks drawing water from and discharging back into river.
9. In any case effluents carrying carcinogenic pollutants should not be allowed to be discharged.

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