DISCUSSION

Yamuna is among 13 major rivers in India flowing through different states. These includes Ganga, Yamuna, Narmada, Brahmaputra, Krishna, Cavery, Damodar, Godavri, Hooghly, Tapti, Gomti, Sona and Chambal besides many other. There was a time when the water in these rivers was very pure and clean, but now the water is so polluted that if taken may speed up the death of person. The water of Yamuna river is so polluted that not to talk of drinking, it is unfit ever for swimming or taking bath.

Government of India has, therefore, enacted laws banning the discharge of industrial or domestic waste into these rivers. Further it has setup the following plans to clean the water of these river.

(i) Ganga Action plan.
(ii) Yamuna Action plan.
(iii) Plan to clean Hooghly river.

The present research project is focussed to study the present status of pollution in the river water of Yamuna.

The samples were collected from

1- 15 km before Taj Kailash Temple
2- 2 km After Taj
3- 12 km Bavan Gadi
4- 38 km Shankarpur(Fatehabad)

The samples were collected in different months from different sites to analyse seasonal changes. In river water survey of the monthly water sampling provide a global view of water quality and may show seasonal variation.

**Turbidity**

Turbidity level of water sample taken from different sites are significantly high, it again confirms the contamination of river water. Turbidity is due to presence of colloidal particles of clay and sand. Chemical and biological contamination also add to the turbidity. Turbidity was detected not only by nephelometer but also by the observation of Tyndal effect.
Alkalinity of water sample

pH: The river water is expected to be slightly acidic due to presence of humic and silicic acids and their salt. In the present work, pH of Yamuna river is found alkaline at different sites as well as in different months. It is due to contamination from industrial and domestic effluents mixing with river water.

The pH was found slightly low in the month of September due to large input of rain water from plains as well as from mountains. In the duration of the present walk there was huge fall in the month of August–September.

S.K. Dhamija, Jain Yatish (1994) studied physics chemical parameters of fresh-water at Jabalpur. Through the period of study changes in these parameters were observed.
**Magnesium**

The concentration of magnesium in river water of Yamuna is in higher side but it is not so high at the significance level of Anova. Even the small increase in magnesium level in water may be harmful to aquatic flora and fauna. High concentration of magnesium add to the total hardness of water.
**Calcium:**

Significantly high amount of calcium was found to be present in Yamuna river irrespective of site and month. However, in the month of September the concentration of calcium was not so high. It is again due to large input of rain water. Similar observation was reported by..............-at al.

Such a high amount of calcium develops hardness in water and hence it is not potable at all. It is harmful for cattle and other animals also. Drinking of such hard water may lead to kidney failure, osteoporosis etc.
Heavy Metal

Significant like in heavy metal contamination is also observed in the water samples collected from Yamuna river. Though mercury is not repeated in observation table because mercury was analysed only in the sample of few sites. Iron metal was found to be significantly high. The findings are identical to Al-Enezi G-etal (2004); Heavy metals are common contaminants of some industrial waste water. They find their way to municipal waste-waters due to industrial discharges into sewage system or through house hold chemicals. The most common heavy metals found in polluted river water are lead, copper, nickel, cadmium, zinc, mercury and chromium. Such metals are toxic and pose serious threats to the environment and public health.

Selective removal of heavy metals from a contaminated waste water/river water combines the benefits of being economically prudent and providing the possibilities of re use/re cycle of the treated waste water effluents and sludges.
Nitrate \( \text{NO}_3^- \)

Higher value of nitrate in river water of Yamuna is attributed to industrial effluents. The nitrates are mainly released into the aquatic environment through waste effluents from organic chemical, gold mining, paint industries etc.

The higher value of nitrate may be fatal to aquatic life. Zbingniew Lewandowaski (1964) exposed that, the influence of nitrate present on the denitrification process using methanol, propanol, glucose, acetone were described. Fatima, Gurbuz, Hasan Ciffci, Ata Akci and Aynur Gul Karahan (2004) obtained, the detoxifaction of nitrates by algar was examined by exposing cultered suspensions of Arthrospira maxima, chlorella sp and scenedsmus obliques in growth media to varying concentration in short-time batch tests.

Higher concentration of nitrates is suggested that the river water of yamuna needs water processing units before it is used.

Jaker Ganga Ram, Rawat Mamta (2003) studied nitrate and calculated most probable number (MPN) in Gulab Sagar of Jodhpur city. The relationship between to parameters was noted as highly significant. The correlation coefficient for nitrate and MPN was found to be 0.11 and the empirical parameters were determined to be \( a=46.25 \) and \( b=12.48 \) respectively.

Jenai B.Sudarshan R, Chaudhry S.B. 2003 found that high concentration of nitrate is related to the decomposition of Mangroves leaves litter.
**BOD and COD**

Dissolved oxygen is most important for all types of aquatic life. The growth of fish is hindered if the concentration of dissolved oxygen is below 6 ppm.

The total amount of oxygen consumed by micro organisms (bacteria) in decomposing the waste (organic matter) present in a certain volume of a sample of water is called Biochemical oxygen demand (BOD) of the water.

The determination of BOD of a sample of water requires 20-30 days for the complete decomposition of the waste which is too long a time to wait. Therefore $\text{BOD}_5$ is determined in the present work that is the amount of oxygen consumed in 5 days.

Water considered pure has $\text{BOD}_5$ of less than 5 ppm where as highly polluted water has $\text{BOD}_5$ value of more than 17 ppm. The present work shows significantly high value of $\text{BOD}_5$.

Presence of textile industries, paper mills, etc will high cellulose content have COD values considerably higher than BOD values as cellulose is not readily attacked by dissolved oxygen. COD values of the present research work are also found significantly high. Thus, the water of Yamuna river seems unfit for survival of aquatic flora and forma.
Halides

(Fluoride and Chloride)

In the present research work, there is no significant observation is reported with respect to chloride but fluoride ion concentration is found significantly high. There is no early research work reported in this connection. However, it is well established that high concentration of fluoride ion may develop fluorosis, teeth decay problems etc.
COLIFORM WILL COUNT

Microbiological analysis of water sample from river Yamuna shows that faecal coliform count is beyond the desirable limit.

Major rivers in India have high bacterial contamination, the Union Ministry of Environment and Forests (MOEF) said in a press release dated December 24, 2008. Yamuna and Ganga top the list of most polluted rivers.

Bacterial contamination in water is indicated by the presence of coliform bacteria that find their way into rivers mostly through untreated sewage and cause water borne diseases.

The MOEF admission on bacterial contamination in rivers seems to indicate a major shift in the way water quality is assessed. Its acceptance that coliform presence is an important parameter for determining water pollution levels is likely to change the pollution profiles of the 282 rivers monitored by the Central Pollution Control Board (CPCB).

Senior officials at the National River Conservation Directorate admitted that coliform is an important indicator of pollution. It hasn't been projected yet because we realize that there is a gap between what our schemes envision and the real state of our rivers.

According to the ministry's norms, river water can be considered fit for bathing if the faecal coli form count is between the desirable limit of 500 and maximum permissible limit of 2,500 MPN (most probable number) per 100 ml. Going by these norms and based on the data published by the CPCB in July 2008, the ministry said water at 84 per cent of the board's river monitoring stations (numbering 1,245) is fit for human consumption.
The CPCB statistics however do not tell the full story. According to CPCB'S own water quality criteria (WQC), based on categorization of river stretches for various uses, 50 per cent of the monitored river stretches are unfit for bathing and another 17 per cent cannot be considered drinking water sources. The WQC is more stringent and mandates that total coli form (TC) including faecal coli form should not exceed 500 MPN. Until now Biological Oxygen Demand (BOD), or the oxygen required for a river to support eco-systems, was the main yardstick for determining river pollution.

The CPCB publication *Water Quality in India: Status and Trends 1999-2001* said presence of coli forms of soil and litter origin had raised doubt on their reliability as an indicator of pathogen (disease causing germs). Also the method used for coli form estimation is not precise. Hence BOD is the single most reliable parameter. Based on this approach the CPCB estimated that 67 per cent of river stretches in India are relatively clean with BOD less than 3 mg per litre. Presence of pathogens is more important for assessing effect of human activity on the river.

**How clean?**

The CPCB data on which the ministry has based its press release also said rivers in India are getting cleaner. According to the data, 46 per cent of the sampling locations had water that confirmed to total coliform standards in 1995. This figure went up to 50 per cent in 2007. The water quality monitoring results with respect to indicator of pathogenic bacteria show that there is gradual improvement in quality.

These numbers too mask the reality. A close look at the data showed major rivers have recorded, coliform levels many times higher than the permissible limit. The number of water monitoring
stations that have recorded high coliform levels, have also gone up from 259 in 1995 to 623 in 2007.

It is also not known how much of India's river length is polluted if we consider both parameters BOD and coliform. In such a situation it is critical to reassess the pollution profile of rivers. Deterioration of river water quality is a reality as cities let out untreated sewage into rivers. By CPCB's own estimate, only 6,000 million litres per day (mid) of the 33,000 mid sewage generated each day is treated. Here too, most sewage treatment plants (STPS) do not meet any standards. Even MOEF standard for treated effluent (from STPS 0,000 MPN-10,000 MPN) is lax.

The environment ministry has promised a rethink by initiating a fresh exercise for 'river conservation strategy' to promote a holistic and integrated approach.
**Suggestions**

The present research work confirms that water of river Yamuna is not only unfit for drinking but also unfit for swimming and bathing also. Government of India should take serious measures at war footing stage, so that, this cultural and religious heritage of India can be preserved.

Some useful suggestion are:

Central salt and Marine Chemical Research Institute (CSMCRI), Bhavnagar, one of the seven chemical science group laboratories under the umbrella of CSIR. It is pioneer Institute in electrodialysis and reverse osmosis technologies. The Institute has also scaled up thin film composite RO members are technologies for seven water applications and installed a number of plants which are being successfully operated. The Yamuna water treatment plant should be established under such useful organizations.

Over the past decade, an important initiative known as green chemistry, the use of chemistry to prevent pollution, has been taken. “Green chemistry” can be defined as the design, development and implementation of chemical products and processes to reduce or eliminate the use and generation of substances hazardous to human health and environment. Green chemistry reduces pollution through fundamental breakthroughs in designing and redesigning chemical processes with an eye towards making them environmentally friendly, that is “benign by design”. In this regard, Dr. Barry Trosts advocates an ‘atom economy’ approach to the synthesis of commercial chemical products such as pharmaceutical, plastics and pesticides. Such synthesis would be designed so that all reactant atoms end up as desired products, and not as wasteful byproducts. This approach
would save money as well as materials and undesired products would not be produced as waste which requires disposal. The reason green chemistry is being adopted so rapidly around the world is because it is a pathway to ensuring economic and environmental prosperity.

The main objectives of green chemistry can be summarized in the following points:

i. It is better to prevent waste than to treat or clean up-waste after it has been created.

ii. Synthetic methods should be designed to maximize the incorporation of all materials used in the process into the final product.

iii. Whenever practicable, synthetic methods should be designed to use and generate substances that possess little or no toxicity to human health and environment.

iv. Chemical products should be designed to affect their desired function while minimizing their toxicity.

v. The use of auxiliary substances (e.g., solvents, separation agents, etc.) should be made unnecessary whenever possible and innocuous when used.

vi. Energy requirements of chemical processes should be recognized for their environmental and economic impacts and should be minimized. If possible, synthetic methods should be conducted at ambient temperature and pressure.

vii. A raw material or feedstock should be renewable rather than depleting whenever technically and economically practicable.

viii. Unnecessary derivatization should be minimized or avoided if possible because such steps require additional reagents and can generate waste.
ix. Catalytic agents as selective as possible should be used.

x. Chemical products should be designed so that at the end of their function they break down into innocuous degradation products and do not persist in the environment.

xi. Substances and the form of a substance used in a chemical process should be chosen to minimize the potential for chemical accidents, including releases, explosion and fires.

Innovative “green” chemical methods already have made an impact on a wide variety of chemical manufacturing processes by decreasing or eliminating the use or creation of toxic.