REPORT OF THE COMMITTEE

ON

POLLUTION CAUSED BY LEATHER TANNING INDUSTRY TO THE WATER BODIES / GROUND WATER IN UNNAO DISTRICT OF UTTAR PRADESH

NIH **CWC** **CGWB**

CPCB **UPPCB**

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CONTRIBUTIONS

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Regional Director, CGWB (NR), Lucknow	… Member
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PREFACE

Smt. Annu Tandon, Hon'ble Member of Parliament (Lok Sabha) has written a letter to Hon'ble Union Minister of Water Resources, Govt. of India regarding the rampant pollution of water bodies and ground water by industrial units especially leather tannery industry in Unnao District of Uttar Pradesh and requested the Hon'ble Union Minister of Water Resources to appoint a special team of investigators to find the facts about the present state of Unnao's water bodies / ground water, how much of Unnao's ground water is affected so far and which particular tanning units are responsible for causing pollution to Unnao's water bodies.

The Ministry of Water Resources, Govt. of India constituted a committee under the Chairmanship of Director, NIH, Roorkee, to find the facts about the present state of Unnao's water bodies / ground water, how much of Unnao's ground water is affected so far and which particular tanning units are responsible for causing pollution to Unnao's water bodies.

Unnao is one of the major industrial towns adjacent to Kanpur having most of the leather, slaughter house, textile, steel and other industries. Unnao industrial area is situated near Kanpur in northern side of River Ganga having more than 50 industrial units mainly tannery. The effluents discharged by the industries, after passing through a Common Effluent Treatment Plant (CETP), is finally discharged in the River Ganga. Some industries also have their own Effluent Treatment Plants (ETP). The quality of ground water in the industrial area is under constant threat of contamination directly or indirectly. Remarkable high concentration of chromium in some parts of ground water of Unnao and Kanpur Districts is a common feature in the region.

The 1st meeting of the Committee constituted by the Ministry of Water Resources, Govt. of India was held in the chamber of Director, NIH, Roorkee on 16th May 2012 to discuss the various aspects of the problem and it was decided to depute a team of officers from NIH, CWC, CGWB, CPCB and UPPCB to Unnao for field investigations in and around Unnao Industrial Area including dumping grounds on National Highway.

The first survey of the Unnao Industrial Area was conducted by the joint team during pre-monsoon season (21-22 May 2012) and 32 water and waste water (effluent) samples were collected from key locations for physico-chemical analysis. Based on the analysis of pre-monsoon data, Part – I of the report was prepared and submitted to MoWR. The physico-chemical analysis of the pre-monsoon samples was carried out at NIH, Roorkee. The second round of sampling from in and around Unnao Industrial Area was carried out during post-monsoon season (5-9 Nov. 2012) and 106 water and waste water (effluent) samples were collected based on the suggestions of the MoWR and other members of the committee. The physico-chemical analysis of the post-monsoon samples was carried out at CWC (for waste water / effluent samples) and CGWB (for ground water samples). The report has been finalized by the committee in its meeting held on 7th Jan. 2013 at NIH, Roorkee.

Raj Deva Singh

(R. D. Singh)
Director, NIH &
Chairman of the Committee

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EXECUTIVE SUMMARY

The Ministry of Water Resources, Govt. of India constituted a committee under the Chairmanship of Director, NIH, Roorkee, to find the facts about the present state of Unnao's water bodies / ground water, how much of Unnao's ground water is affected so far and which particular tanning units are responsible for causing pollution to Unnao's water bodies.

The 1st meeting of the Committee was held in the chamber of Director, NIH, Roorkee on 16th May 2012 to discuss the various aspects of the problem and following decisions were taken:

i) A team consisting of officers from NIH, CWC, CGWB, CPCB and UPPCB will visit the problem area and will identify the drains, ETP drain, dumping sites, degraded ground water quality sites in and around the Unnao industrial area based on the recent findings of CGWB, IITR, CPCB and UPPCB for collection of effluent, ground water and soil samples in the pre-monsoon season.

ii) The study will involve extensive pre- and post-monsoon survey and sampling of surface and ground water to arrive at the conclusion and hence requires one water year for completion of study.

iii) Collection and sharing of the information, literature and studies carried out by different organizations.

iv) Preparation of inception report based on the survey and findings of CGWB, CWC, IITR, CPCB and UPPCB for submitting it to the Ministry of Water Resources (MoWR) by 1st June 2012.

v) Preparation of final report based on field surveys and results of collected sample analysis and submission to MoWR by Dec. 2012 for further necessary action. The report will contain the discussion on the results obtained and appropriate recommendations by the participating organizations.

The first survey of the Unnao Industrial Area was conducted by the joint team consisting of representatives from NIH, Roorkee; CWC, New Delhi; CGWB (NR), Lucknow; CPCB (Zonal Office), Lucknow and UPPCB, Lucknow during 21-22 May 2012 and 32 water and waste water (effluent) samples were collected from key locations for physico-chemical analysis.

The second round of sampling from in and around Unnao Industrial Area was carried out during 5-9 Nov. 2012 incorporating suggestions of the MoWR and other members of the committee and the report has been finalized in its meeting held on 7th Jan. 2013 at NIH, Roorkee.

Based on the analysis of the samples during pre- and post-monsoon seasons, the following inferences are drawn:

i) The values of TDS, TSS, total chromium, COD and BOD at the outlet of the CETP Unnao are not in conformity with the effluent standards notified vide S.No. 55(B); G.S.R. 93(E) dated 21.2.1991 under Environment (Protection) Act, 1986 for discharge of effluent into inland surface water.

ii) The values of TSS, COD and BOD in the effluents of UPSIDC drain are not in conformity with the effluent standards notified vide G.S.R. 422(E) dated

19.5.1993 under Environment (Protection) Act, 1986 for discharge of effluent into inland surface water.

iii) The values of phosphate, fluoride, COD and BOD in the sewage drain are not in conformity with the effluent standards notified vide G.S.R. 422(E) dated 19.5.1993 under Environment (Protection) Act, 1986 for discharge of effluent into inland surface water.

iv) Loni Drain effluents are high in TSS, fluoride, COD and BOD and are not in conformity with the effluent standards notified vide G.S.R. 422(E) dated 19.5.1993 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water.

v) The treated effluent quality of Banthar CETP is not in conformity with the effluent standards notified vide G.S.R. 422(E) dated 19.5.1993 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water with respect to TDS, TSS, total chromium, COD and BOD.

vi) Samples from UPSIDC drain before and after joining of Banthar CETP drain were high in TSS, COD and BOD and are not in conformity with the effluent standards notified vide G.S.R. 422(E) dated 19.5.1993 for under Environment (Protection) Act, 1986 discharge of effluents into inland surface water.

vii) Effluent discharged by M/s Mirja International Ltd. are not in conformity with the effluent standards notified vide S.No. 57; G.S.R. 475(E) dated 5.5.1992 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water for TSS and BOD.

viii) Effluent discharge from M/s Mustang Leather Pvt. Ltd. is high in TSS, total chromium and BOD and exceed the prescribed limit notified vide S.No. 57; G.S.R. 475(E) dated 5.5.1992 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water.

ix) The analysis results of the effluents discharged by M/s Sadaf Enterprises Pvt. Ltd. indicates that the values of TSS and BOD are not in conformity with the effluent standards notified vide S.No. 57; G.S.R. 475(E) dated 5.5.1992 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water.

x) Effluent discharged by M/s Rehman Industries Ltd. do not conform to the standards notified vide S.No. 57; G.S.R. 475(E) dated 5.5.1992 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water in respect of BOD.

xi) The effluent discharged by M/s Indagro Foods Ltd. do not conform to the standards notified vide S.No. 50; G.S.R. 93(E) dated 21.2.1991 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water in respect of TSS and BOD.

xii) The analysis results of the effluents discharged by M/s AOB Exports Pvt. Ltd. indicates that the values of TSS, COD and BOD are not in conformity with the effluent standards notified vide S.No. 50; G.S.R. 93(E) dated 21.2.1991 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water.

xiii) The analysis results of sewage drain indicates that the values of fluoride, COD and BOD are not in conformity with the effluent standards notified vide G.S.R.

422(E) dated 19.5.1993 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water

xiv) The analysis results of City Jail Drain indicates that the values of TSS, iron, COD and BOD are not in conformity with the effluent standards notified vide G.S.R. 422(E) dated 19.5.1993 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water.

xv) The analysis results of the effluents discharged by M/s Omega International indicates that the values of BOD are not in conformity with the effluent standards notified vide S.No. 57; G.S.R. 475(E) dated 5.5.1992 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water.

xvi) The analysis results of the effluents discharged by M/s Allied Leather Finishers Pvt. Ltd. indicates that the values of total chromium and BOD are not in conformity with the effluent standards notified vide S.No. 57; G.S.R. 475(E) dated 5.5.1992 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water.

xvii) The analysis results of the effluents discharged by M/s Rustam Food Pvt. Ltd. indicates that the values of BOD are not in conformity with the effluent standards notified vide G.S.R. 422(E) dated 19.5.1993 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water.

xviii) The analysis results of the combined effluents of M/s Falak Enterprises and M/s Asharfi Agro Byproducts indicates that the values of phosphate, fluoride, COD and BOD are not in conformity with the effluent standards notified vide G.S.R. 422(E) dated 19.5.1993 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water.

xix) The analysis results of the effluent of M/s Resinova Chemicals indicates that the values of COD and BOD are not in conformity with the effluent standards notified vide G.S.R. 422(E) dated 19.5.1993 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water.

xx) The analysis results of the effluent of M/s Handloom Bhandar indicates that the values of COD and BOD are not in conformity with the effluent standards notified vide S.No. 92; G.S.R. 742(E) dated 25.9.2000 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water.

xxi) The analysis results of the effluent of M/s Rimjhim Stainless Ltd. indicates that the values of pH, lead, total chromium, COD and BOD are not in conformity with the effluent standards notified vide S.No. 30; GSR 913(E) dated 24.10.1989 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water.

xxii) The analysis results of the effluent of M/s Bajaj Kagaj Udyog Ltd. indicates that the values of BOD are not in conformity with the effluent standards notified vide G.S.R. 422(E) dated 19.5.1993 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water.

xxiii) The analysis results of the effluent of M/s J. S. International indicates that the values of BOD are not in conformity with the effluent standards notified vide S.No. 50; G.S.R. 93(E) dated 21.2.1991 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water.

xxiv) The analysis results of the effluent of M/s Mahavir Spin Fabrics indicates that the values of COD and BOD are not in conformity with the effluent standards notified vide S.No. 92; G.S.R. 742(E) dated 25.9.2000 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water.

xxv) The analysis results of the effluent of M/s Balaji Industries Ltd. indicates that the values of COD and BOD are not in conformity with the effluent standards notified vide S.No. 92; G.S.R. 742(E) dated 25.9.2000 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water.

xxvi) The analysis results of the effluent of M/s ACI Oils Pvt. Ltd. indicates that the values of COD and BOD are not in conformity with the effluent standards notified vide S.No. 67; G.S.R. 176(E) dated 2.4.1996 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water.

xxvii) The analysis results of the effluent of M/s Jeet Dyeing Industries indicates that the values of COD and BOD are not in conformity with the effluent standards notified vide S.No. 92; G.S.R. 742(E) dated 25.9.2000 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water.

xxviii) The analysis results of the effluent of M/s Sadaf Dyeing and Proofing indicates that the values of COD and BOD are not in conformity with the effluent standards notified vide S.No. 92; G.S.R. 742(E) dated 25.9.2000 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water.

xxix) The analysis results of the effluent of M/s Universal Yarn and Textile Pvt. Ltd. indicates that the values of COD and BOD are not in conformity with the effluent standards notified vide S.No. 92; G.S.R. 742(E) dated 25.9.2000 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water.

xxx) The analysis of ground water samples indicates that out of the seven samples, the concentration of TDS exceeded the maximum permissible limit of 2000 mg/L in four samples during pre-monsoon season. The hardness, chloride and sulphate values also exceeded the permissible limit in ground water samples of Dharam Kanta, Village Dakari and Maswasi during pre-monsoon season.

xxxi) The analysis of heavy metals in the ground water samples indicate that the presence of heavy metals has been recorded at many locations and the water quality standards have been violated for iron, manganese, nickel and chromium in about 50% of the samples analysed during pre-monsoon season.

xxxii) The analysis results of post-monsoon season indicate that electrical conductivity values of 5 samples (Sample No. G-5, G-6, G-26, G-44, G-55) is more than 3000 µS/cm and one sample at Dakari (Sample No. G-5) has 7100 µS/ cm. Nitrate values in Sample No. G-9, G-10, G-26, G-39, G-44 has been found more than 45 mg/L, probably due to contamination by industrial / domestic waste disposal. Fluoride values are more than 1.5 mg/L in Sample No. G-6, G-46, G-54 probably due to localized geogenic / anthropogenic activities. Total hardness in Sample No. G-5, G-6, G-9, G-26, G-44, G-47, G-51, G-55 is more than 600 mg/L. Hexavalent Cr in Sample No. G-12 and G-26 is remarkably high probably due to impact of dumped Cr waste in the ground. Lead content in Sample No. G-5, G-6, G-7, G-8, G-10, G-18, G-20, G-22, G-23, G-26, G-30, G-44, G-48, G-51 and G-55 exceed

the permissible limit of 50 µg/L. The impact of chromium contamination has been observed in shallow aquifers.

xxxiii) The quality of water supply from Babuganj Tubewell No. 11 violated the drinking water standards for hardness, nitrate and magnesium. The ground water of Lily Park Awas Vikas Tubewell No. 4 violated the drinking water standard for fluoride which may be attributed to localized geogenic/anthopogenic activities.

1. Introduction

Smt. Annu Tandon, Hon'ble Member of Parliament (Lok Sabha) has written a letter to Hon'ble Union Minister of Water Resources, Govt. of India regarding the rampant pollution of water bodies and ground water by industrial units especially leather tannery industry in Unnao District of Uttar Pradesh (Annex – I). Hon'ble Member of Parliament has requested the Hon'ble Union Minister of Water Resources to appoint a special team of investigators to find the facts about the present state of Unnao's water bodies / ground water, how much of Unnao's ground water is affected so far and which particular tanning units are responsible for causing pollution to Unnao's water bodies. Hon'ble Member of Parliament has also forwarded a report consisting of findings from two independent agencies, Indian Institute of Toxicology Research (IITR), Lucknow and Central Ground Water Board (CGWB), Northern Region, Lucknow. Some photographs of polluted drains and industrial dumps along the National Highway and within the industrial area were also attached with the report.

The Ministry of Water Resources, Govt. of India constituted a committee consisting of the following to find the facts about the present state of Unnao's water bodies / ground water, how much of Unnao's ground water is affected so far and which particular tanning units are responsible for causing pollution to Unnao's water bodies (Annex – II).

Director, NIH	… Chairman
Director (RDD), CWC	… Member
Regional Director, CGWB (NR)	… Member

The committee was also empowered to co-opt member from CPCB and UPPCB.

The terms of reference of the committee are as follows:

i) Taking up scientific studies in and around Unnao industrial area including dumping grounds on National Highway
ii) To investigate the present extent to which Unnao water bodies/ground water has been affected by the industrial pollution
iii) Identification of industrial units responsible for causing pollution and discharging untreated industrial effluents directly into the surface water/ground water bodies and indiscriminate dumping of industrial solid waste along with the National Highway and near water bodies
iv) Study of health impacts of ground water contamination.

2. Review of Special Investigation Reports

2.1 Analysis of Water Samples from Selected Sites in Unnao, IITR, Lucknow (April 2010)

A special short term investigation report on 'Analysis of Water Samples from Selected Sites in Unnao' was prepared by Indian Institute of Toxicological Research (IITR), Lucknow based on the investigations carried out during February/March 2010. Twenty four samples (18 from drinking water sources and 6 from effluents) were collected from selected sites in Unnao and analysed. The main findings of the study are –

i) Out of 18 drinking water samples, 13 samples were found to exceed the recommended TDS limit, 12 samples were found to exceed the limits in terms of total hardness, 13 samples were found to exceed the limit for fluoride, 6 samples were found to exceed the limit for sulphate, 4 samples were found to exceed the limit for chloride, 5 samples were found to exceed the limit for alkalinity, 2 samples were found to exceed the limit for manganese, 9 samples were found to exceed the limit for iron and 1 sample was found to exceed the limit for mercury.

ii) Out of six effluent samples, (from CETP and Distillery Sites), 4 samples exceed the limit for fluoride and 2 samples exceed the limit for chromium.

iii) BOD and COD values exceed the prescribed limit in all the effluent samples.

2.2 Ground Water Contamination in Industrial Area, Unnao District, Uttar Pradesh, CGWB, NR (April 2010)

A special short term investigation report on 'Ground Water Contamination in Industrial Area, Unnao District, Uttar Pradesh' was prepared by Central Ground Water Board (Northern Region), Lucknow based on the investigations carried out during April 2010. Forty five samples from 25 sites were collected from hand pump and industrial drains from Unnao Industrial Area and analysed. The results of analysis are given in Annex - III. The main findings of the study are:

i) Total hardness in 33% ground water samples exceeds the permissible limit.

ii) Iron concentration in 40% ground water samples exceeds the permissible limit.

iii) Manganese concentration in 50% ground water samples exceeds the permissible limit.

iv) In effluent samples, concentration of chromium before treatment in Bauther ETP and Dahi Chowki CETP was 14.76 and 0.520 mg/L and after treatment 3.254 and 0.490 mg/L respectively.

v) Concentration of copper, cadmium, zinc and nickel found within the permissible limit in ground water and effluent samples.

2.3 Arsenic Contamination in Ground Water in Some Parts of Unnao District, Uttar Pradesh, CGWB, NR (January 2012)

Another special short term investigation report on 'Arsenic Contamination in Ground Water in Some Parts of Unnao District, Uttar Pradesh' was prepared by Central Ground Water Board (Northern Region), Lucknow based on the investigations carried out during January 2012. A total of 69 ground water samples were collected and analysed for arsenic contents. The results of the analysis are given in Annex – IV. The main findings and recommendations of the study are -

i) Significant contamination of arsenic in the ground water structures of the Shuklaganj, Dakari, katari, Buddha, Antwa, Maswari and Rishinagar areas in excess than the permissible limit of 50 µg/L has been found.
ii) High values of arsenic in ground water has been recorded from Shuklaganj area (637 µg/L), Dakari (118 µg/L), Katari (113 µg/L), Bhuddha (97 µg/L), Antwa (126 µg/L), Maswari (68 µ/L) and Rishinagar (85 µg/L).
iii) All the area fall in the upper part of Ganga River and the reducing environment for conversion of As(V) to As(III) and its more solubility is probably the reason for presence of arsenic in ground water structures.
iv) The affected area of upper part of Ganga River in Unnao District needs proper monitoring and micro level investigation for presence of arsenic in these areas.
v) Remedial measures should be undertaken for the people of the areas.
vi) Alternative sources of potable water should be made available to the affected public in these areas.

2.4 Ground Water Pollution by Chromium and Fluoride in Some Parts of Unnao District, Uttar Pradesh, CGWB, NR (March 2012)

Another special short term investigation report on 'Ground Water Pollution by Chromium and Fluoride in Some Parts of Unnao District, Uttar Pradesh' was prepared by Central Ground Water Board (Northern Region), Lucknow based on the investigations carried out during March 2012. A total of 69 water and waste water samples were collected and analysed for pH, EC, chromium (Total and Hexavalent) and fluoride concentrations. The results of the analysis are given in Annex – V. The main findings and recommendations of the study are -

i) The concentration of chromium, electrical conductivity and fluoride content in some samples of ground / surface water are higher than the permissible limit prescribed by BIS (IS:10500:1991).
ii) The effluent samples near CEPT at Dahi Chowki has recorded total chromium as 3984 µg/L. Mirza tannery drain recorded total chromium as 4455 µg/L.
iii) High values of hexavalent chromium has been recorded near J R Inter College, Dharamkanta (602 µg/L); Shivnagar (141 µg/L); Maduwasi (102 µg/L); Masnagar (54 µg/L); Dakari (50 µg/L) and Lauikhera (45 µg/L) areas in Unnao.

iv) It has been observed that in Dharamkata area, fresh dumping of industrial solid waste containing chromium salts is being done.

v) High salinity in ground water has also been observed in Laukhera, Dakari, Madhuwasi area of industrial pocket of Unnao district.

vi) At few locations high fluoride content (> 1.5 mg/L) has been detected.

vii) The presence of chromium (total) in surface as well as ground water indicates that surface water is polluting ground water, however the quantum and area at present is very small but it has started polluting the ground water.

viii) Hexavalent chromium has been recorded in Dharmkanta, near Unnao bypass area, where industrial solid waste is being dumped on the road which should be stopped immediately by the concerned authority.

ix) Effluent treatment plants should be in proper working condition as effluent near Dahi Chowki has been found to contain chromium.

x) Disposal of solid and liquid wastes should be properly managed as per Central Pollution Control Board guidelines. The CPCB should be asked to look into this matter and a detailed study should be undertaken.

xi) Deeper aquifers, which are safe from contaminants, can be used for drinking purposes.

xii) Remedial measures should be under taken for the people of the areas.

3. Description of the Study Area

3.1 General Description

Unnao is one of the major industrial towns adjacent to Kanpur having most of the cotton, leather, pharmaceutical, steel and other industries. The Unnao industrial area and surroundings villages of Unnao district lies between $26^0$26' and $26^0$41' North latitudes and $80^0$15' and $80^0$33' East longitudes, falling in the survey of India Toposheet No. 63B. It is bounded in the north by Safipur block, in the east by the Bichhia block, in the south Sikandarpur Karon block, whereas the Ganga river in the west separates it from the district of Kanpur. The total area is about 220 km^2.

Unnao industrial area is situated near Kanpur in northern side of Ganga River having more than 50 industrial units mainly tannery, catering the need of nation. The effluents discharged by the industries, after passing through a common effluent treatment plant having approx. 70% treating capacity, is finally discharged in the Ganga River. The quality of ground water in the industrial areas is under constant threat of contamination directly or indirectly. Remarkable high concentration of chromium in some parts of ground water of Unnao and Kanpur districts is a common feature in the region.tgbr

3.2 Topography

Unnao district represents flat topography with a general elevation of 98 m (322 ft.) covering an area of 4558 km^2. By virtue of its geographic setting in the great (Ganga) plains, the land is highly fertile. The soil is mostly alluvial.

The district is mainly drained by the river Ganga and its tributaries Kalyani, Khar, Loni and Marahai in the western part of the district and by Sai river in the eastern part of the district. All these rivers are perennial in nature. About 87% area of the net sown area (3,00,000 hectares) is irrigated both by surface water (Sharda Canal network system) and ground water through shallow and moderately deep tubewells. The share of surface water irrigation is 48% while that of ground water is 52%.

3.3 Geomorphology

Geologically Unnao district lies in Ganga plain, one of the most densely populated regions, one of the largest ground water repositories and one of the largest fluvial systems on Earth wherein, monsoon rain causes large scale sediment-water movement and reworking of sediments. The area is beset with alluvium of Quaternary age consisting of older alluvium of middle to upper Pleistocene and newer alluvium of Holocene. The climate of the study area is semi-arid type.

Geomorphologically, the Plain shows a south to southeasterly sloping planar surface in the northern part, formed due to contraction and expansion of alluvial fans in response to the climatic changes during the Quarternary (Ghosh and Singh, 1988). There is a regional plateau or

upland surface (T_2) sloping towards east and south-east. Another regional surface (T_1) is developed within the major river valleys. These surfaces have developed in response to sea-level and climatic changes during Quarternary period (Singh, 1987). It is observed that in rivers flowing NW-SE, the southern bank shows prominent cliffs, while in the north, broad flood planis are developed (Singh and Rastogi, 1973).

Through time, the Gangetic Plain has expanded southwards in response to thrust-fold loading in the Himalaya. The subsurface data in the alluvium of the southern marginal plain shows that above the basement, there is a succession of sediment derived from the Peninsular region, dominated by pink-colored arkoses sands. This zone is capped by a sequence of sediments from Himalayan source, which are essentially grey coloured, micaceous sub-greywacke type (Singh and Bajpai, 1989).

In Kanpur (& Unnao) region, Ganga river flows along NW-SE trending weak zone (a tectonic lineament) showing a prominent escarpment on the southern side and well-developed flood plain in the northern side (Singh and Rastogi, 1973). This weak zone has also controlled the subsurface stratigraphy in the alluvium (Singh and Bajpai, 1989).

The present-day Ganga river near Unnao-Kanpur is a 2-3 km wide distinctly braided stream with only one or two braid bars across the channel. These braid bars / sand flats have shifted downstream as well as accreted vertically. Vertically accretion has lead to the development of permanent sandy islands, which become vegetated, as they are not inundated by average annual floods. The river is undergoing vertical accretion at a rate of about 25cm/10 years (Singh et al., 1990). A comparison of the area of active channel, active sand bar, vegetated bar has shown that over a period of 60 years, there has been a 57% reduction in the active channel area and a substantial increase in the area of active sand bar and vegetated bar. The sand of the river channel is micaceous and very fine (Singh et al., 1990).

Geomorphology and drainage type combined with sedimentation processes play a substantial role on dispersion and transport patterns of metals bound to sediments and soils. It has been divided into five independent geochemical domains on the basis of sediment-geomorphic, hydrological and geochemical characters. The monsoon hydrography and physico-chemical parameters (pH, conductivity) of the river and urban drain waters play a prominent role in regulating the concentrations and behavior of the metals in the aquatic system of the Plain.

3.4 Soil

Soil found in Unnao industrial and surroundings village of Unnao district exhibit a wide variance in composition and appearance. The major part of area consists of ordinary soils known locally as Bhur or sand on the ridges, Matiar or clay in the topographic lows and Dumat or loam on the plains. Clay is dominant in the areas where "Reh" or Usar prevails. Alluvial soils of river valleys notable the "Kachhar" of the Ganga formed by repeated deposition of silt brought down by the existing river system during floods.

3.5 Hydrogeology

3.5.1 General Geology

The area is a part of the Central Ganga alluvial plain mainly constituted of the clay, silt, sand, gravel and kankar sediments of quaternary age. These alluvial deposits of the area may be broadly classified into newer and older litho-units on the basis of sedimentary constitution, depositional and developmental geological history. The generalised sub-surface geological sequence is as follows:

Age	Litho-Unit	Sedimentary Constitution
Holocene	Newer Alluvium	Channel Alluvium Lavee Alluvium
---------- Disconformity ----------		
Middle to Upper Pleistocene	Varanasi Older Alluvium	Clayey Facies Sandy Facies
---------- Unconformity ----------		
	(Basement Rock)	

The older alluvium occupies a large part of the district (Unnao) in the topographically high land which does not get flooded by river whereas the newer alluvium occupies the area of low relief along the courses of the Ganga river and is susceptible to flooding during period. The upper layer of alluvium is composed of sandy loam and clayey loam.

Sub-surface geology of the area is revealed from the study of strata logs of boreholes drilled by Central Ground Water Board, which are given below:

S.No.	Location	Depth drilled (mbgl)	Depth of Construction of well (mbgl)	Zones tapped range (m)	Aquifer material thickness tapped (m)	Yield (lps)
1	Unnao (Avas Vikas Colony) $26^0$31'05" $80^0$30'05"	452.00	427.00	300 – 310 316 – 328 341 – 347 378 – 421	Sand 71	38.33
2	Chamrauli $26^0$35'30" $80^0$36'00"	454.00	445.00	396 – 314 324 – 333 336 – 342 360 – 372 396 – 405 429 – 438	Sand 71	33.83
3	Maraunda $26^0$39'04" $80^0$18'44"	452.00	410.00	295 – 307 310 – 319 326 – 332 335 – 341 351 – 379 394 – 405	Sand 72	27.83

4	Bhadarka $26^0$27'04" $80^0$29'20"	437.50	433.00	287 – 293 296 – 303 310 – 319 328 – 342 347 – 355 358 – 362 375 – 382 388 – 396 398 – 404 419 – 430	Sand 80	58.33
5	Pannalal Park Unnao Town $26^0$33'00" $80^0$39'30" (Borehole)	569.27	-	-	-	-

Drilling has been carried out to the maximum depth of 569.27 m at Panna Lal Park, Unnao Town by C.G.W.B. for a deposit well during 1975 which was abandoned due to the absence of promising water bearing granular zone. The bed rock was not encountered in above any of the boreholes in the Unnao industrial and surrounding village area.

India Mark II hand pumps have been constructed down to the depth of about 30-40 m and state tubewells as on average to the depth of 80-170 m in the area. As per surveyed in village and industrial area, private hand pumps have been constructed down to the depth of about 15-20 m. The details of hydrogeological data of state tubewells in the area are given below:

S.No.	Location	Depth Drilled (m)	Depth of Tubewell (m)	Granular Zones Encountered	Aquifer Materials
1	Khwajajipur	135.65	121.92	32.00 – 80.77 103.63 – 118.87	Medium Sand
2	Chhattu Kheda	123.45	103.63	32.00 – 59.43 82.00 – 105.15	Medium Sand
3	Khatai Kheda	97.55	88.40	64.00 – 88.40	Coarse Sand and Gravel
4	Awasthi Kheda	153.92	135.63	32.00 – 45.73 99.05 – 132.65	Medium Sand
5	Sikandarpur	153.90	68.58	13.72 – 67.03	Fine and Medium Sand

A sub-surface geological cross has been drawn along the A-B line section showing deposition of aquifer in the area on litho-logs of exploratory boreholes (CGWB). The area has in general three prominent surface granular zones.

(i) The Upper or Phreatic Aquifer System – It is occurring a cropping of top-soil upto the depth of about 90 m bgl.

(ii) The Middle Aquifer System – The thick massive clay zone is extending from 100 to 250 m bgl depths which have the middle aquifer system in the form of thin lenticular granular zones.

(iii) The Lower Aquifer System – The lower aquifer system is generally extending below the depth of 250 m upto the achieved drilled depth of 454.28 m bgl.

3.5.2 Depth to Water Level

To study the water level behaviour and hydrogeological conditions, three (3) dugwells (NHS) Unnao, Santa Khera and Sikandarpur Sirosi in Unnao industrial and surrounding village area have been measured from year 2002 to 2012 (August 2012). The depth to water level data report for ten year from 2002 to 2012 (upto August 2012), water level ranges (m) of each NHS of area is given below:

S.No.	NHS (Location)	Depth to water level ranges (Pre-monsoon) (m) bgl	Depth to water level ranges (Post-monsoon) (m) bgl	Year
1	Unnao	6.27 – 9.70	3.05 – 7.45	2003-2012 (upto Aug.)
2	Santa Khera	1.59 – 4.93	1.23 – 2.98	2002-2012 (upto Aug.)
3	Sikandarpur	12.63 – 14.33	11.48 – 13.93	2002-2012 (upto Aug.)

The average depth to water level during pre-monsoon period ranges from 1.59 to 14.33 m bgl and during post-monsoon period ranges from 1.23 to 13.93 m bgl in the area of Unnao industrial and surrounding villages. Water level fluctuation in the area varies from 2.00 to 3.00 m.

In order to study the behaviour of ground water regime in space and time, the available water level data of N.H.S. located in the area has been analysed for the period 2002 to 2012, the water level trend has been worked out is given below:

Trend of Water Level in Unnao District, U.P.
(From Year 2002 to Year 2011)

District/State : Unnao/Uttar Pradesh
Block : Sikandarpur Sarausi

S.No.	Location	Pre-monsoon		Post-monsoon	
		Rise (m/year)	*Fall (m/year)*	*Rise (m/year)*	*Fall (m/year)*
1	Santa Khera	-	0.1021	0.0430	-
2	Sikanderpur 1	-	0.0643	-	0.0868
3	Unnao	-	0.0822	-	0.3970

3.6 Source of Drinking Water

In industrial area of Unnao city, demand of water supply is met from tube wells (Deep and Shallow), India Mark II and private hand pumps. The details of ground water structures and population served in industrial area and surrounding village of Unnao city is given below:

S.No.	Village	Population (Approx.)	Ground Water Structures
1.	Chandipur N 26^{0}32"29'8" E 80^{0}32'00.6"	2000	India Mark II and Private Hand Pumps
2.	Gajauli N 26^{0}33'25^0.1" E 80^{0}32'26.3"	4000	- do -
3.	Ram Purwa N 26^{0}32'5.3" E80^{0}32'51.9"	1100	- do -
4.	Dahi Chowk N 26^{0}33'53.8" E 80^{0}32'18.5"	1200	- do -
5.	Munkund Khera N 26^{0}34'30.6" E 80^{0}31'01.9"	4000	- do -
6.	Banthar Village N 26^{0}29'10.6" E 80^{0}28'0.37"	5000	- do -
7.	Gadar Khera N 26^{0}31'07.0" E 80^{0}29'31.2"	2000	- do -
8.	Magarwara N 26^{0}30'49.9" E 80^{0}25'46.2"	15000	- do -
9.	Zalim Khera N 26^{0}28'11.0" E 80^{0}27'10.8"	1500	- do -
10.	Lau Khera N 26^{0}28'19.6" E 80^{0}27'05.9"	300	- do -
11.	Bijalamau N 26^{0}27'23.2" E 80^{0}26'26.3"	250	- do -
12.	Dakai Village N 26^{0}27'06.7" E 80^{0}26'48.5"	200	- do -
13.	Garmau N 26^{0}30'50.9" E 80^{0}26'19.8"	5000	- do -
14.	Viflamau N 26^{0}27'25.7" E 80^{0}26'39.8"	2700	- do -

India Mark II hand pumps and private hand pumps are constructed extensively in the area to catch the requirement of drinking water to the population living in the industrial area and surrounding villages. Water supply in these villages is not from Ganga river.

3.7 Status of Water Polluting Industries

Industries in Unnao District are located at three locations, UPSIDC Industrial Area Site - 1, UPSIDC Industrial Area Site - 2 and UPSIDC Industrial Area Site - 3 (Leather Technology Park, Banthar). Apart from these three industrial sites, industries are also located in Akarampur-Chakarampur Industrial Area. In total, there are 62 industrial units mainly consisting of leather processing, slaughter house and textiles (Table 3.1).

Table 3.1 Details of Different Industries in Unnao District (Source: UPPCB)

S. No.	Name & Address of Industry	Date of Start	Daily Production	Working Status during Sampling	Water Consum-ption (KLD)	Effluent Discharge (KLD)	Treatment Facility
Unnao Industrial Area Site 1							
1.	Rustom Foods Pvt. Ltd.	2008	25 ton frozen meat	Working	25	20	ETP
2	AOV Exports Pvt. Ltd.	2011	84 ton frozen meat	Working	700	350	ETP
3	Rimjhim Stainless Ltd.	2009	Steel Structure	Not Working	10	2	ETP
4	Falak Enterprises	2009	Bone Tallow	Working			ETP
5	Asharfi Agro Bio Products	2009	Bone Tallow	Working			ETP
Unnao Industrial Area Site 2							
6	G. B. S. Tanners	2000	3 ton Finished Leather	Working	120	85	PETP, Member CETP
7	Model Tanners	2004	200 hide Finished Leather	Working	100	60	PETP, Member CETP
8	Kings International	1995	200 hide Finished Leather	Working	80	50	PETP, Member CETP
9	Super Hose Ltd. (Shole Div.)	1990	200 hide Finished Leather	Working	160	100	PETP, Member CETP
10	Super Hose Ltd. (Goat Div.)	1996	5.9 ton Finished Leather	Working	235	165	PETP, Member CETP
11	Model Agpet Product		Dog Chew	Working	50	40	PETP, Member CETP
12	Maria Export		Dog Chew	Working	50	40	PETP, Member CETP
13	Sultan Tannery & Leather Products	1996	100 hide Finished Leather	Working	80	60	PETP, Member CETP
14	Leader Fabrics	1984	4 ton Finished Leather	Working	160	120	PETP, Member CETP
15	Cresent Tanners-Unit 1	1992	5 ton Finished Leather	Working	200	150	PETP, Member CETP
16	Cresent Tanners-Unit 2	1994	5 ton Finished Leather	Working	100	70	PETP, Member CETP
17	Super Hose Ltd. (Chrome Div.)	1985	700 hide Finished Leather	Working	560	450	PETP, Member CETP
18	Iqbal Leathers Limited	1986	400 hide Finished Leather	Working	320	180	PETP, Member CETP
19	Calico Trends	2007	150 hide Finished Leather	Working	120	90	PETP, Member CETP
20	Omega International	2009	30 hide Finished Leather	Working	12	9	ETP
21	Allied Leather Finishers Pvt. Ltd.	1997	30 hide Finished Leather	Working	100	30	ETP
22	Al Super Frozen Foods Pvt. Ltd.		50 ton Frozen Meat	Not Working	50	40	ETP
23	Indagro Foods Ltd.	1998	280 ton Frozen Meat	Working	921	850	ETP

24	Standard Agrovet Pvt. Ltd.	2009	Bone Tallow	Not Working			ETP
Industrial Area Site 3 (Leather Technology Park, Banthar)							
25	Homera Tanners Pvt. Ltd.	2012	100 hide Finished Leather	Working			PETP, Member CETP
26	Calico Traders	2005	360 hide Finished Leather	Working	288	216	PETP, Member CETP
27	Mash International	2004	Dog Chew	Working	30	20	PETP, Member CETP
28	Bengal Leather Board	2006	500 Pieces Leather Board	Working	50	40	PETP, Member CETP
29	Model Tanners (India) Pvt. Ltd.	2004	600 hide Finished Leather	Working	480	360	PETP, Member CETP
30	Alladad Tannery (Rehman Ind. Ltd.)	2005	600 hide Finished Leather	Working	480	360	PETP, Member CETP
31	Super Tannery Ltd.	2006	360 hide Finished Leather	Working	288	200	PETP, Member CETP
32	Model Exim (Unit-2)	2007	130 hide Finished Leather	Working	100	65	PETP, Member CETP
33	Ruksh International	2006	150 hide Finished Leather	Working	120	90	PETP, Member CETP
34	Pacific Export	2007	180 hide Finished Leather	Working	145	100	PETP, Member CETP
34	Northern Tannery	2008	175 hide Finished Leather	Working	70	30	PETP, Member CETP
36	Calico Impex	2008	150 hide Finished Leather	Working	120	80	PETP, Member CETP
37	Allied Exims	2007	120 hide Finished Leather	Working	96	70	PETP, Member CETP
38	Oxford Tannery	2007	180 hide Finished Leather	Working	140	100	PETP, Member CETP
39	Islam Tanners	2008	60 hide Finished Leather	Working	48	30	PETP, Member CETP
40	Rohit Surfactant (Liyan Global Pvt. Ltd.)	2010	360 hide Finished Leather	Working	288	216	PETP, Member CETP
41	Upper India Pvt. Ltd.	2010	90 hide Finished Leather	Working	72	44	PETP, Member CETP
42	Everest Tannery Pvt. Ltd.	2009	150 hide Finished Leather	Working	120	90	PETP, Member CETP
43	A.T.O Exim	2010	150 hide Finished Leather	Working	120	90	PETP, Member CETP
44	Saba Exports	2010	182 hide Finished Leather	Working	145	102	PETP, Member CETP
45	J. S. International	2007	60 ton Frozen Meat	Working	500	350	ETP
Akarampur-Chakrampur Industrial Area							
46	Sadaf Enterprises Pvt. Ltd.	1998	500 hide Finished Leather	Working	400	350	ETP
47	Garima Industries	2008	1200 mtr. Fabric	Working	10	5	ETP under construction
48	Balaji Industries	2008	2000 mtr. Fabric	Working	10	5	ETP under construction

49	A.C.I Oils Pvt. Ltd.	2000	15 ton edible oil 30 ton Vanaspati	Working	150	50	ETP
50	Global Smelters (Rimjhim Stainless Ltd.)	2008	Steel Bars	Working	150	50	ETP
51	Handloom Bhandar	2007	120000 mtr. Fabric	Working	200	100	ETP
52	Durga Dyeing Industries		1000 mtr. Fabric & Paper board	Working	5	0	ETP
53	Resinova Chemicals Pvt. Ltd.	1992	25 ton Resin	Working	50	5	ETP
54	Rehman Industries Ltd.	2000	1000 hide Finished Leather	Working	800	480	ETP
55	Mustang Leather Pvt. Ltd.	2001	120 hide Finished Leather	Working	96	72	ETP
56	Mahavir Spin Fabrics Pvt. Ltd.	2002	20000 mtr. Fabric	Working	300	150	ETP
57	Jeet Dyeing industries	2004	3000 mtr. Fabric	Working	10	5	ETP
58	Sadaf Dyeing & Proofing	2008	1500 mtr. Fabric	Working	10	5	ETP
59	Mirza International Pvt. Ltd.	1980	1500 hide Finished Leather	Working	900	700	ETP
60	Universal Yarn & Textile Ltd.	2003	3000 mtr. Fabric	Working	100	30	ETP
61	Unnao Distillery & Beverages Ltd.	1896	15 KL Alcohol	Not Working	-	0	ETP-Recycle
Jamuka Village, Unnao							
62	Bajaj Kagaj Udyog Ltd.	2008	60 ton Paper	Working	2500	250	ETP

Industrial Area Site – 1 consists of 5 units (One slaughter house, one meat processing unit, two fat processing units and one metal unit). Approximately 0.75 MLD effluent is generated from all these units and is discharged in Loni Drain after treatment.

CETP Unnao Outlet into Loni Drain

CETP Banthar Outlet into UPSIDC Drain

Industrial Area Site – 2 consists of 21 tannery units out of which 14 are operational and 7 are non operational since long. Out of 14 tannery units, 2 units have their own effluent treatment plant and effluent from 12 tanneries goes to combined effluent treatment plant (CETP) after undergoing primary treatment which involves chrome recovery and suspended solids removal in general. Apart from tanneries, there is one slaughter house and one meat processing unit, both having their own effluent treatment plant. These units produce approximately 4.37 MLD effluent. The CETP was made operational in October 1995 at the cost of Rs. 195 lacs. The designed treatment capacity of plant is 2.15 MLD. CETP consists of bar screen, equalization tank, primary clarifier for suspended solids removal, 2-stage aerobic bio reactor and clarifiers for removal of organics, tertiary clarifier for removal of organics and suspended solids by adsorption on chemical sludge, followed by multigrade filter and activated carbon filter for final polishing. It is operated and maintained by Unnao Tanneries Pollution Control Company.

Treated effluent from Site – 1 and Site – 2 are discharged in Loni drain. Approximately, 5 MLD untreated sewage from the city is also discharged in the Loni drain. Loni drain meets River Ganga in Raebareli District after travelling approximately 146 km. Water from Loni drain is utilized for irrigation by the farmers.

Industrial Area Site – 3 (Leather Technology Park, Banthar) consists of 42 industrial plots, out of which 21 industrial units exists at present. Eighteen tannery industries, 1 leather board unit and 1 dog chew unit discharge their effluent in CETP Banthar. One Slaughter house in the Leather Technology Park (LTP) has its own effluent treatment plant. CETP Banthar has 42 members and was established in October 2004 at the cost of Rs. 6 Crores. Treatment capacity of CETP Banthar is 4.5 MLD. For removal/reduction of suspended solids and organics, the CETP is having bar screen, equalization tank, primary clarifier, 2-stage biological treatment consisting of aeration tank and secondary clarifier, tertiary clarifier, multigrade filter and activated carbon filter. CETP is operated and maintained by Banthar Industrial Pollution Control Company. At present, CETP is receiving 3.8 MLD effluent from 21 industries. This means, existing CETP would not be able to treat the entire effluent from the LTP if all the 42 industrial units comes in existence and hence needs expansion. Treated effluent from CETP as well as slaughter house is discharged in UPSIDC Drain which finally meets Jail Drain. City Jail Drain also receives approximately 15 MLD untreated sewage. This drain meets River Ganga after travelling some 30 km distance.

Industrial Site Akarampur-Chakarampur consists of 16 manufacturing / processing units, out of which 4 are tanneries (3 units are closed since long), 1 distillery, 8 textile & dyeing units, 1 chemical unit, 1 edible oil unit and 1 metal industry. All the units in this industrial site have their own effluent treatment plants. Approximately 3.5 MLD treated effluent from these industries are discharged in the City Jail Drain.

List of different industries and their discharge is given in Table 3.2 to 3.3. Layout and flow chart showing various processes in tannery industries are shown in Figs. 3.1 to 3.3.

Table 3.2 List of Industries in Unnao District (Source: UPPCB)

S.No.	Industries	Numbers
1.	CETP Unnao (Site 2) - Tannery Members	12
2.	CETP Unnao (Site 2) - Other Members	02
3.	CETP Banthar (Site 1) - Tannery Members	18
4.	CETP Banthar (Site 1) - Other Members	02
5.	Tanneries with ETP	06
6.	Distillery	01
7.	Galvanizing and Pickling	02
8.	Paper Mill	01
9.	Textile Industry	08
10.	Slaughter House	03
11.	Meat Processing	02
12.	Fat Industry	03
13.	Bio Fertilizer Industry	01
14.	Edible Oil	01
	Total	**62**

Note: Industries at S.No. 5 to 14 have their own effluent treatment plants.

Table 3.3 Discharges in Loni and City Jail Drain (Source: UPPCB)

S.No.	Source	Quantity (MLD)	
		Loni Drain	**City Jail Drain**
1.	Industrial Area Site – 1	0.75	-
2.	Industrial Area Site – 2	4.37	-
3.	Industrial Area Site – 3 (Leather Technology Park, Banthar)	-	3.8
4.	Akarampur-Chakarampur Industrial Site	-	3.5
5.	Domestic Sewage	5.0	15.0
	Total	**10.12**	**22.3**

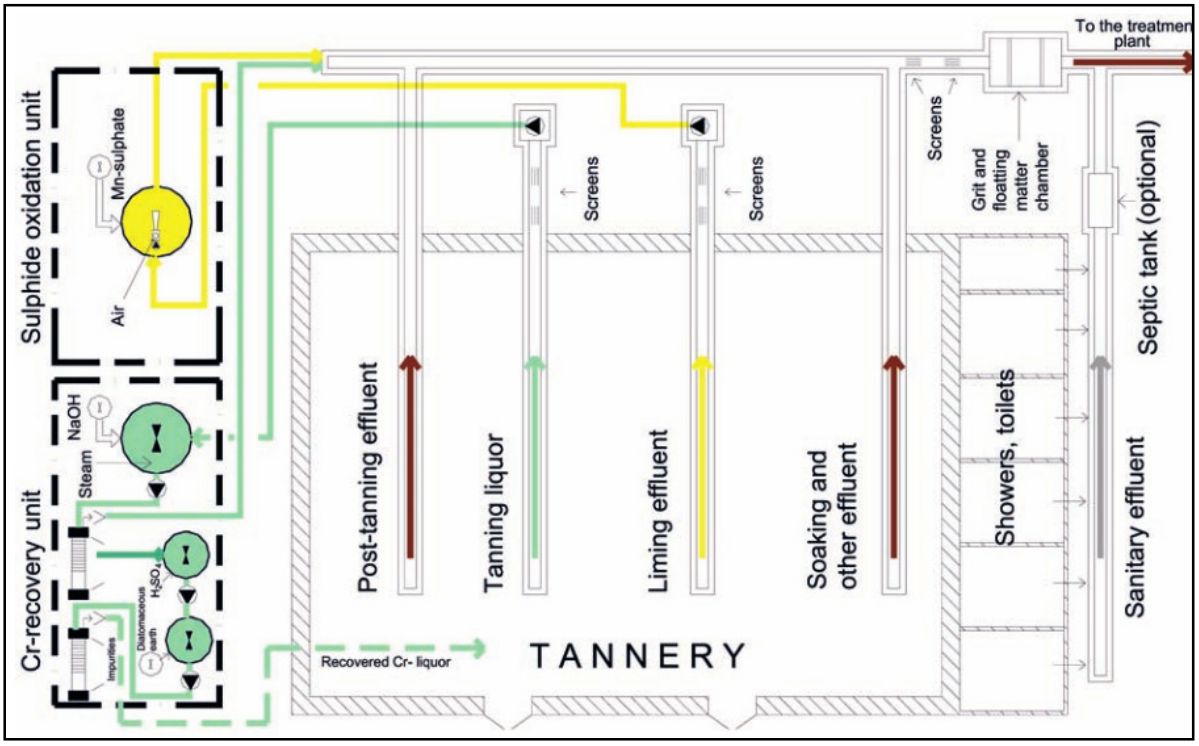

Fig. 3.1 Layout of in-house segregation of streams, including chrome recycling and oxidation of sulphides in liming effluent in a Tannery

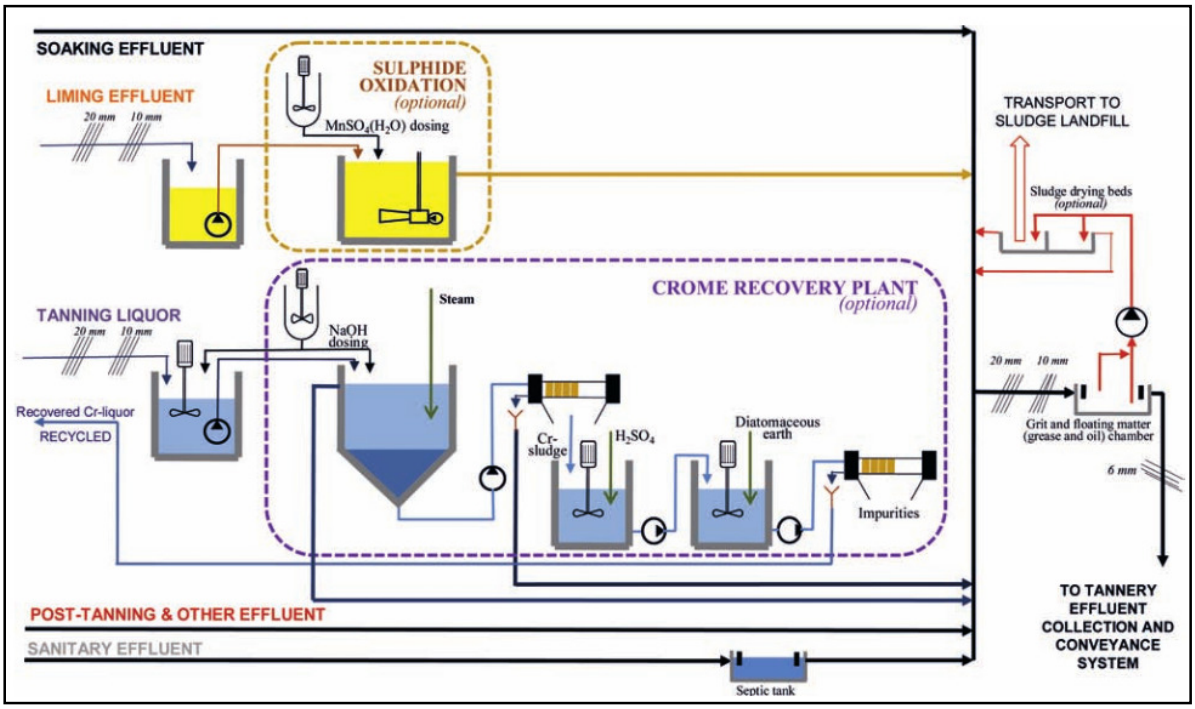

Fig. 3.2 Flowchart of in-house segregation of streams, including chrome recycling, treatment of liming effluents and pre-treatment of mixed effluent in a Tannery

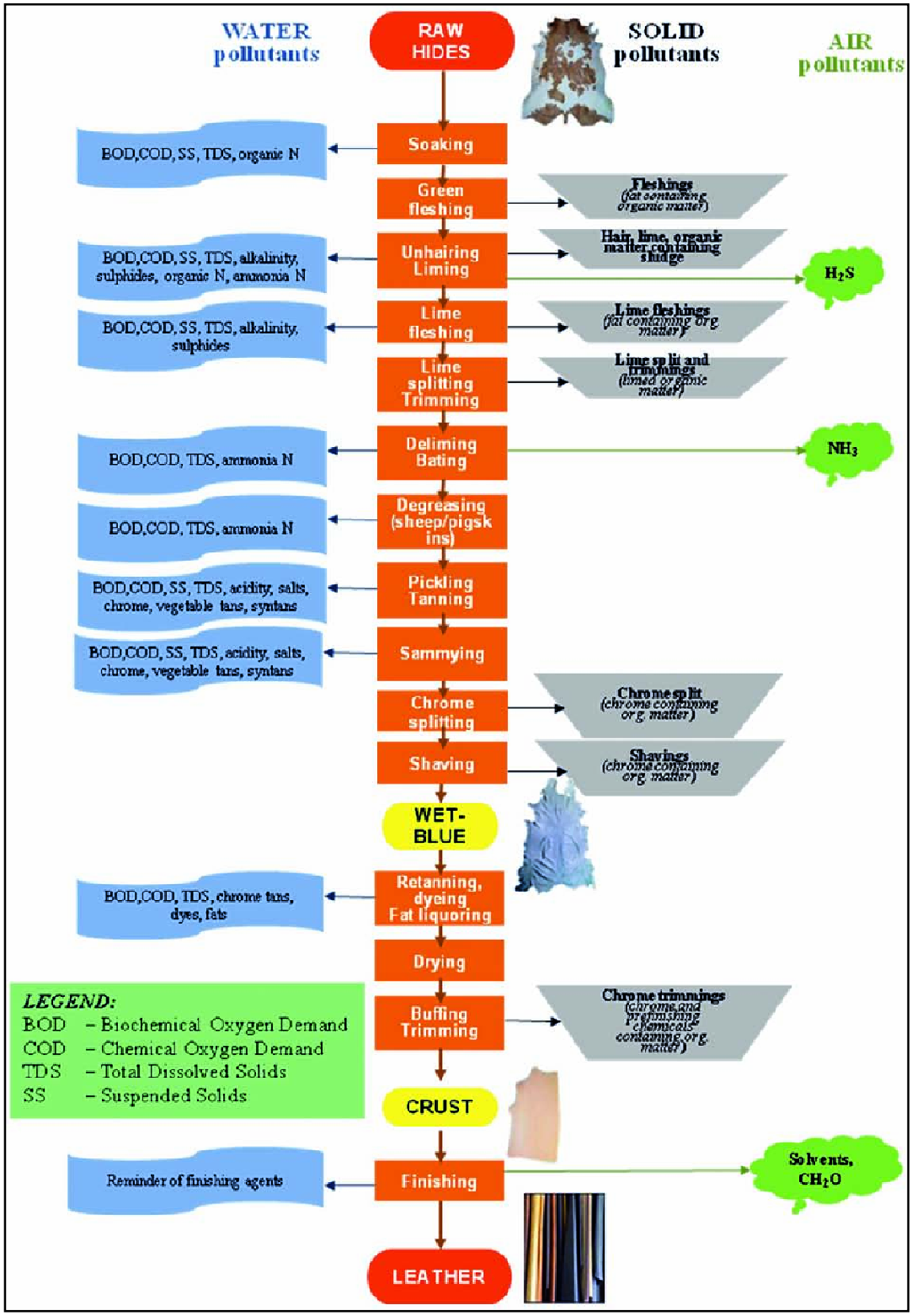

Fig. 3.3 Flowchart showing various processes in a Tannery

4. Meetings of the Committee

The 1st meeting of the Committee constituted by the Ministry of Water Resources, Govt. of India to find out the facts about the present state of Unnao's water bodies / ground water was held in the chamber of Director, NIH, Roorkee on 16th May 2012 to discuss the various aspects of the problem. The following were present in the meeting:

Committee Members / Co-opted Members

1.	Sri. R. D. Singh Director, NIH, Roorkee	Chairman
2.	Sri. K. B. Biswas Regional Director, CGWB (NR), Lucknow	Member
3.	Dr. Zakir Hussain Incharge, NRWQ Lab., CWC, New Delhi (Representing Director, RDD, CWC, New Delhi)	Member
4.	Dr. R. K. Singh Sc. 'C', CPCB (Zonal Office), Lucknow (Representative of CPCB, New Delhi)	Co-opted Member

Invitees

1. Dr. S. K. Jain
   Sc. 'F' & Head, WRS Division, NIH, Roorkee
2. Sri. Omkar Singh
   Sc. 'E2', EHD, NIH, Roorkee
3. Dr Ram Prakash
   Sc. 'C', CGWB (NR), Lucknow
4. Dr. M. K. Sharma
   Sc. 'C', EHD, NIH, Roorkee
5. Dr. Rajesh Singh
   Sc. 'B', NIH, Roorkee

The various aspects of rampant pollution of water bodies and ground water by industrial units especially leather tannery industry in Unnao District of Uttar Pradesh were discussed along with the observations of the studies carried out by CGWB and IITR, Lucknow and the following decisions were made:

i) A team consisting of officers from NIH, CWC, CGWB, CPCB and UPPCB will visit the problem area and will identify the drains, ETP drain, dumping sites, degraded ground water quality sites in and around the Unnao industrial area based on the recent findings of CGWB, IITR, CPCB and UPPCB for collection of effluent, ground water and soil samples in the pre-monsoon season.

ii) The study will involve extensive pre- and post-monsoon survey and sampling of surface and ground water to arrive at the conclusion and hence requires one water year for completion of study.

iii) Collection and sharing of the information, literature and studies carried out by different organizations.

iv) Preparation of inception report based on the survey and findings of CGWB, CWC, IITR, CPCB and UPPCB for submitting it to the Ministry of Water Resources (MoWR) by 1st June 2012.

v) Preparation of final report based on field surveys and results of collected sample analysis and submission to MoWR by Dec. 2012 for further necessary action. The report will contain the discussion on the results obtained and appropriate recommendations by the participating organizations.

The 2nd meeting of the Committee was held on 29th May 2012 at NIH, Roorkee to finalize the inception report prepared based on the first survey of the study area and findings of CGWB, CWC, IITR, CPCB and UPPCB.

The 3rd meeting of the Committee was held on 24th Sep. 2012 to finalize the Part – I of the report in the light of the comments received from MoWR and other members of the committee and to finalize the plan of action for the post-monsoon sampling/analysis.

The 4th meeting of the Committee was held on 7th Jan. 2013 to discuss the post-monsoon data and finalize the report of the committee.

5. Survey of the Study Area

The first survey of the Unnao Industrial Area was conducted by the joint team consisting of representatives from NIH, Roorkee; CWC, Lucknow; CGWB (NR), Lucknow; CPCB (Zonal Office), Lucknow and UPSPCB, Lucknow during 21-22 May 2012. The team visited the area and collected 32 waste water / effluent and ground water samples from key locations for physico-chemical analysis. The second round of sampling (post-monsoon) of the Unnao Industrial Area was conducted by the joint team during 5-9 Nov. 2012 and 106 waste water / effluent and ground water samples were collected from deeper and shallow aquifers from surrounding / adjacent villages covering whole industrial area and nearby villages to see the lateral and vertical extent of pollution. Line diagram showing the sampling locations are shown in Fig. 5.1 and details are given in Table 5.1 and 5.2.

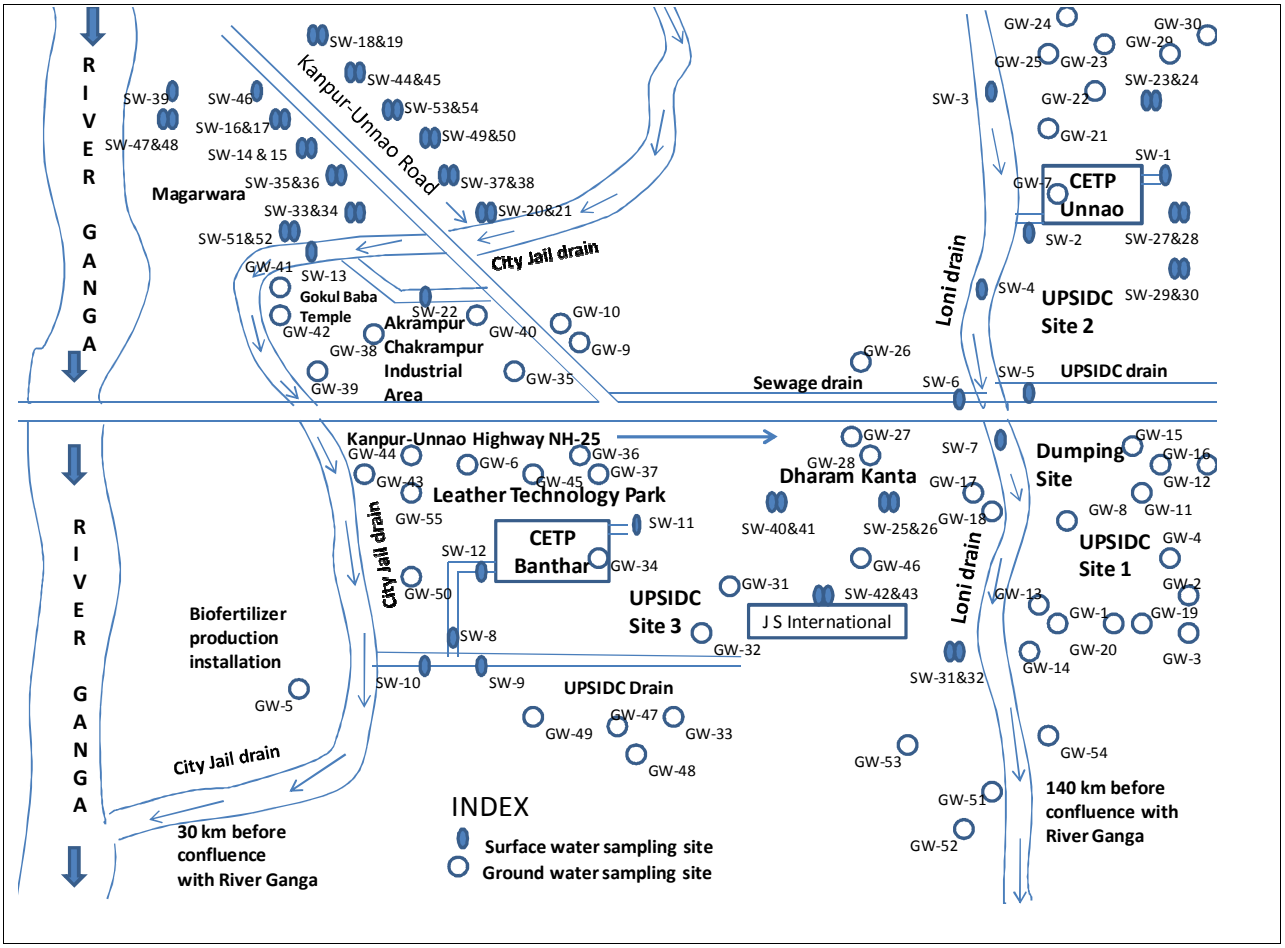

Fig. 5.1 Unnao Industrial Area Showing Location of Sampling Points

Table 5.1 Details of Sampling Locations for Waste Water / Effluent Samples

S.No.	Sample ID	Sampling Location	Locality
CETP/ETP/Drain			
1.	SW-1	CETP Unnao Inlet at Plant	Ind. Area Site-2
2.	SW-2	CETP Unnao Outlet at Plant	Ind. Area Site-2
3.	SW-3	U/S of Loni Drain at Railway Bridge before Joining of CETP Unnao Outlet	Ind. Area Site-2
4.	SW-4	Loni Drain after Joining of CETP Unnao Outlet	Ind. Area Site-2
5.	SW-5	UPSIDC Drain at Bridge near CETP Unnao	Ind. Area Site-2
6.	SW-6	Unlined Sewage Drain at Bridge near CETP	Ind. Area Site-2
7.	SW-7	Loni Drain D/S of the Bridge after joining of UPSIDC Drain and Sewage Drain	Ind. Area Site-2
8.	SW-8	CETP Banthar Drain before Mixing	Banthar
9.	SW-9	UPSIDC Drain	Banthar
10.	SW-10	UPSIDC Drain	Banthar
11.	SW-11	CETP Banthar Inlet at Plant	Banthar
12.	SW-12	CETP Banthar Outlet at Plant	Banthar
13.	SW-13	City Jail Drain (near Gokul Baba Temple)	Magarwara
14.	SW-14	ETP Inlet of M/s Mirza International Pvt. Ltd.	Magarwara
15.	SW-15	ETP Outlet of M/s Mirza International Pvt. Ltd.	Magarwara
16.	SW-16	ETP Inlet of M/s Mustang Leather Pvt. Ltd.	Magarwara
17.	SW-17	ETP Outlet of M/s Mustang Leather Pvt. Ltd.	Magarwara
18.	SW-18	ETP Inlet of M/s Sadaf Enterprises Pvt. Ltd.	Magarwara
19.	SW-19	ETP Outlet of M/s Sadaf Enterprises Pvt. Ltd.	Magarwara
20.	SW-20	ETP Inlet of M/s Rehman Industries Ltd.	Magarwara
21	SW-21	ETP Outlet of M/s Rehman Industries Ltd.	Magarwara
22.	SW-22	Sewage Drain (Model Vihar Colony)	Unnao
23.	SW-23	ETP Inlet of M/s Indagro Foods Ltd.	Ind. Area Site-2
24.	SW-24	ETP Outlet of M/s Indagro Foods Ltd.	Ind. Area Site-2
25.	SW-25	ETP Inlet of M/s AOV Exports Pvt. Ltd.	Ind. Area Site-1
26.	SW-26	ETP Outlet of M/s AOV Exports Pvt. Ltd.	Ind. Area Site-1
27.	SW-27	ETP Inlet of M/s Omega International	Ind. Area Site-2
28.	SW-28	ETP Outlet of M/s Omega International	Ind. Area Site-2
29.	SW-29	ETP Inlet of M/s Allied Leather Finisher Pvt. Ltd.	Ind. Area Site-2
30.	SW-30	ETP Outlet of M/s Allied Leather Finisher Pvt. Ltd.	Ind. Area Site-2
31.	SW-31	ETP Inlet of M/s Rustom Food Pvt. Ltd.	Ind. Area Site-1
32.	SW-32	ETP Outlet of M/s Rustom Food Pvt. Ltd.	Ind. Area Site-1
33.	SW-33	ETP Inlet of M/s Falak Enterprizes & Asharfi Agri Bioproduct	Ind. Area Site-1
34.	SW-34	ETP Outlet of M/s Falak Enterprises & Asharfi Agro Byoproducts	Ind. Area Site-1
35.	SW-35	ETP Inlet of M/s Resinova Chemicals Pvt. Ltd.	Magarwara
36.	SW-36	ETP Outlet of M/s Resinova Chemicals Pvt. Ltd.	Magarwara
37.	SW-37	ETP Inlet of M/s Handloom Bhandar	Magarwara
38.	SW-38	ETP Outlet of M/s Handloom Bhandar	Magarwara
39.	SW-39	ETP Outlet of M/s Rimjhim Stainless Ltd. (Formerly M/s Global Smelters)	Akrampur

40.	SW-40	ETP Inlet of M/s Bajaj Kagaj Udyog Ltd.	Jamuka
41.	SW-41	ETP Outlet of M/s Bajaj Kagaj Udyog Ltd.	Jamuka
42.	SW-42	ETP Inlet of M/s J S International	Banthar
43.	SW-43	ETP Outlet of M/s J S International	Banthar
44.	SW-44	ETP Inlet of M/s Mahavir Spin Fabrics Pvt. Ltd.	Magarwara
45.	SW-45	ETP Outlet of M/s Mahavir Spin Fabrics Pvt. Ltd.	Magarwara
46.	SW-46	Outlet of M/s Balaji Industries Ltd.	Akrampur
47.	SW-47	ETP Inlet of M/s ACI Oils Pvt. Ltd.	Akrampur
48.	SW-48	ETP Outlet of M/s ACI Oils Pvt. Ltd.	Akrampur
49.	SW-49	ETP Inlet of M/s Jeet Dyeing Industries	Magarwara
50.	SW-50	ETP Outlet of M/s Jeet Dyeing Industries	Magarwara
51.	SW-51	ETP Inlet of M/s Sadaf Dyeing & Proofing	Magarwara
52.	SW-52	ETP Outlet of M/s Sadaf Dyeing & Proofing	Magarwara
53.	SW-53	ETP Inlet of M/s Universal Yarn & Textile Pvt. Ltd.	Magarwara
54.	SW-54	ETP Outlet of M/s Universal Yarn & Textile Pvt. Ltd.	Magarwara

Table 5.2 Details of Ground Water Sampling Locations

S.No.	Sample ID	Sampling Location	Type	Depth (feet)	Locality
1.	G-1	Chandpur village	TW	160	Ind. Area Site-1
2.	G-2	Opp. Shivam Medical Store, Dahi Chowk	IM II	80	Ind. Area Site-1
3.	G-3	H/o Sri Pintoo Gupta, Shivnagar	Pvt. HP	50	Ind. Area Site-1
4.	G-4	M/s Janta Timber Mart, Dharam Kanta	Pvt. BW	40	Ind. Area Site-1
5.	G-5	Boiler Point, Dakari	Pvt. HP	45	Unnao
6.	G-6	Opp. H/o Sri Shankar Singh, Maswasi	IM II	80	Maswasi
7.	G-7	CETP Unnao Complex	IM II	140	Ind. Area Site-2
8.	G-8	Haze Manzoor Alam India Ltd.	IM II	80	Ind. Area Site-1
9.	G-9	Babuganj Nagar Palika, TW No.11	TW	650	Ind. Area Site-1
10.	G-10	Babuganj Hata Temple	IM II	80	Ind. Area Site-1
11.	G-11	Opp. Super House Ltd., Roadways Workshop	IM II	100	Ind. Area Site-1
12.	G-12	Opp. Super House Ltd., Roadways Workshop	IM II	80	Ind. Area Site-1
13.	G-13	Rustam Food Ltd.	IM II	80	Ind. Area Site-1
14.	G-14	H/o Sri Ram Gopal, Chandpur	IM II	80	Ind. Area Site-1
15.	G-15	Indian Industries Association	IM II	100	Ind. Area Site-1
16.	G-16	Near H/o Sri Dhani Ram, Gajauli village	IM II	80	Ind. Area Site-1
17.	G-17	Village Rambakhs Khera	IM II	80	Ind. Area Site-1
18.	G-18	H/o Sri Ramsajeevan, Rambakhs Khera	Pvt. HP	50	Ind. Area Site-1
19.	G-19	Near H/o Sri Vinod, Durjan Khera	Pvt. HP	80	Ind. Area Site-1
20.	G-20	Durjan Khera village	IM II	40	Ind. Area Site-1
21	G-21	Opp. M/s Cresent Tanners Pvt. Ltd.	IM II	85	Ind. Area Site-2
22.	G-22	Teekar Railway Crossing, Gate No. 31	IM II	85	Ind. Area Site-2
23.	G-23	H/o Sri Munnulal, village Mukund Khera	Pvt.H	70	Ind. Area Site-2

			P		
24.	G-24	Gayatri Coaching Centre, Teekar Crossing	IM II	110	Ind. Area Site-2
25.	G-25	H/o Shyam Mohan, Teekar Crossing	Pvt. HP	40	Ind. Area Site-2
26.	G-26	Opp. M/s Elena Company	IM II	80	Ind. Area Site-2
27.	G-27	Police Chowki, Dahi	Sub. Pump	110	Ind. Area Site-2
28.	G-28	Opp. Amar Dharam Kanta, village Jhanjari	IM II	80	Ind. Area Site-2
29.	G-29	Opp. H/o Sri Suryapal Yadav, village Jhanjari	IM II	80	Ind. Area Site-2
30.	G-30	H/o Sri Rajesh Yadav, village Jhanjari	Pvt. HP	50	Ind. Area Site-2
31.	G-31	Power House, Leather Technology Park, Banthar	IM II	80	Ind. Area Site-2
32.	G-32	H/o Sri Chhote Lal, UPSIDC, Banthar	Sub.P ump	130	Ind. Area Site-2
33.	G-33	H/o Sri Sudhir Gupta, Banthar	IM II	200	Ind. Area Site-2
34.	G-34	CETP Banthar	Sub. Pump	150	Ind. Area Site-2
35.	G-35	Nagar Palika Parishad, Pitambar Nagar, TW No. 10	TW	650	Magarwara
36.	G-36	Nagar Palika Parishad, Kashif Ali Sarai, TW No. 3	TW	650	Magarwara
37.	G-37	Opp. H/o Sri Deshraj, Dalit Basti, Gadan Khera	IM II	80	Magarwara
38.	G-38	H/o Sri Rajjan Lal Yadav, Adarsh Nagar	IM II	110	Magarwara
39.	G-39	Opp. M/s Zamzam Tannery, Shekhpur	IM II	120	Magarwara
40.	G-40	M/s Super Tannery Limited, Akrampur	Sub. Pump	120	Akrampur
41.	G-41	Gokul Baba Crossing	IM II	80	Magarwara
42.	G-42	Gokul Baba Temple	IM II	110	Magarwara
43.	G-43	Payjal Yojna, Maswasi	TW	1750	Maswasi
44.	G-44	Payjal Yojna, Maswasi	IM II	80	Maswasi
45.	G-45	Near H/o Sri Ashok Kumar, Galgala	IM II	80	Unnao
46.	G-46	Nagar Palika Parishad, Lily Park, Awas Vikas, B Block, TW No. 4	TW	1500	Unnao
47.	G-47	Opp. H/o Sri Jagan Nath, Jalim Khera	OW	15	Unnao
48.	G-48	H/o Sri Jagan Nath, Jalim Khera	Pvt. HP	30	Unnao
49.	G-49	H/o Shiv Mangal, Laukhera	IM II	80	Unnao
50.	G-50	Prathmik Vidyalaya, Karni Bijalamau	IM II	80	Unnao
51.	G-51	Opp. H/o Sri Bachchu Singh, Tribhuvan Khera	Pvt. HP	30	Unnao
52.	G-52	H/o Sri Bhopal Verma, Bijalamau	Pvt. HP	30	Unnao
53.	G-53	Marhala Crossing, Chandrashekhar Azad Marg	Pvt. HP	65	Unnao
54.	G-54	H/o Sri Suraj Singh, Deora Khurd	Pvt. HP	50	Unnao
55.	G-55	Opp. Banerjee Hospital, Magarwara	IM II	80	Magarwara

6. Analytical Methodology

Water and waste water (Effluent) samples were collected in polyethylene bottles using dip/grab sampling method during pre-monsoon (May 21-22, 2012) and post-monsoon (Nov. 5-9, 2012) seasons and preserved by using appropriate reagents as per standard methods (Jain and Bhatia, 1985). All glassware and other containers used for trace element analysis were thoroughly cleaned, soaked in 10% nitric acid for 48 h and finally rinsed with de-ionized water several times prior to use.

The physico-chemical analysis was performed as per Standard Methods for the Examination of Water and Wastewater (APHA, 1992; Jain and Bhatia, 1988). The details of analytical methods and equipment used in the analysis are given in Table 6.1.

Table 6.1 Analytical Methods and Equipment Used in the Analysis

S.No.	Parameter	Method	Equipment Used
1.	pH	Electrometric	pH Meter
2.	Conductivity/TDS	Electrometric	Conductivity Meter
3.	Suspended Solids	Gravemetrically	-
4.	Alkalinity	Titration by H_2SO_4	-
5.	Hardness	Titration by EDTA	-
6.	Chloride	Titration by $AgNO_3$	-
7.	Sulphate	Turbidimetric	Turbidity Meter
8.	Nitrate	Ion Chromatography	Ion Chromatograph
9.	Phosphate	Molybdophosphoric acid	UV-VIS Spectrophotometer
10.	Fluoride	Ion Chromatography	Ion Chromatograph
11.	Sodium	Flame emission	Flame Photometer
12.	Potassium	Flame emission	Flame Photometer
13.	Calcium	Titration by EDTA	-
14.	Magnesium	Titration by EDTA	-
15.	DO	Winkler titration method	-
16.	BOD	5 days incubation at 20°C followed by titration	BOD Incubator
17.	COD	Digestion followed by titration	COD Digester
18.	Iron	Digestion followed by Atomic Spectrophotometer	Atomic Absorption Spectrometer
19.	Manganese		
20.	Copper		
21.	Nickel		
22.	Chromium		
23.	Lead		
24.	Cadmium		
25.	Zinc		

7. Results and Discussion

Unnao is one of the major industrial towns adjacent to Kanpur having most of the leather, slaughter house, textile, steel and other industries. Unnao industrial area is situated near Kanpur in northern side of River Ganga having more than 50 industrial units mainly tannery. The effluents discharged by the industries, after passing through a Common Effluent Treatment Plant (CETP), is finally discharged in the River Ganga. Some industries also have their own Effluent Treatment Plants (ETP). The water quality data of river Ganga at upstream and downstream of the discharge of treated effluent as monitored by CWC is given in Annex – VI and VII.

Industries in Unnao District are located at three locations, UPSIDC Industrial Area Site - 1, UPSIDC Industrial Area Site - 2 and UPSIDC Industrial Area Site - 3 (Leather Technology Park, Banthar). Apart from these three industrial sites, industries are also located in Akarampur-Chakarampur Industrial Area.

The quality of ground water in the industrial area is under constant threat of contamination directly or indirectly. Remarkable high concentration of chromium in some parts of ground water of Unnao and Kanpur Districts is a common feature in the region.

All the areas monitored have insufficient provision for collection and disposal of sewage as well as industrial effluents. The existing situation has high potential of ground water contamination. The injudicious disposal of solid waste has further compounded the problem.

Chrome bearing solid waste was found illegally dumped along National Highway (Shyam Shanti Uchh Shiksha Sansthan Premises, Near JAAR Inter College and Slaughter House Dumping Site). The development around Janta Dharam Kanta along National Highway has come on Basic Chrome Sulfate (BCS) laden solid waste. Ground water sample collected from this site was yellow in color indicating high Cr^{+6} contamination.

Chrome Bearing Solid Waste Dumping Site along National Highway

Chrome Bearing Solid Waste Dumping Site Near JAAR Inter College

Indiscriminate and illegal bio-fertilizer industries are also mushrooming throughout the industrial area specially Dakari Village. Shaving wastes (containing chromium) from tanneries are being used as raw materials by these industries. These units have potential hazards for air, soil and water environment.

Illegal Manufacturing of Bio-fertilizer from Leather Shaving Waste

Waste Slaughter House Dumping Site

The water and wastewater/effluent samples collected from various sites have been analysed and their characteristics are given in Tables 7.1 to 7.28.

7.1 Characteristics of Industrial Effluents / Drains

7.1.1 Characteristics of Effluents at Inlet and Outlet of CETP Unnao

The characteristics of effluents at the inlet and outlet of CETP Unnao along with effluent standards are given in Table 7.1.

Table 7.1 Effluent Characteristics at Inlet and Outlet of CETP Unnao

S.No.	Parameters	Inlet (SW-1)		Outlet (SW-2)		Effluent Standards
		Pre-monsoon	Post-monsoon	Pre-monsoon	Post-monsoon	
1.	pH	7.9	7.6	8.0	7.7	5.5-9.0
2.	TDS, mg/L	12243	9900	11226	9500	2100
3.	TSS, mg/L	390	-	245	-	100
4.	Copper, mg/L	0.03	0.18	0.02	0.15	3
5.	Nickel, mg/L	0.15	0.19	0.09	0.06	3
6.	Lead, mg/L	0.08	0.06	0.05	0.04	0.1
7.	Cadmium, mg/L	0.01	ND	0.01	ND	1
8.	Zinc, mg/L	0.63	0.16	0.07	0.09	5
9.	Total Chromium, mg/L	3.06	6.87	1.31	3.67	2
10.	Arsenic, mg/L	-	0.09	-	0.08	0.2
11.	Fluoride, mg/L	-	1.5	-	1.5	2
12.	COD, mg/L	3788	2650	1240	850	250
13.	BOD, mg/L	680	902	98	353	30

From the above results, it is evident that values of TDS, TSS, Total Chromium, COD and BOD at the outlet of the CETP Unnao are not in conformity with the effluent standards notified vide S.No. 55(B); G.S.R. 93(E) dated 21.2.1991 under Environment (Protection) Act, 1986 for discharge of effluent into inland surface water and needs appropriate statutory action by UPPCB/CPCB. The reasons for under performance of CETP should also be explored through performance audit by an expert agency.

Industrial effluents with such higher values than the permissible limits if discharged into inland surface water will lead to pollution of the water bodies. Health impacts of various contaminants are given in Annex - VIII.

7.1.2 Characteristics of Effluent in UPSIDC Drain and Sewage Drain at Bridge near CETP Unnao

The characteristics of effluents in UPSIDC Drain and Sewage Drain at bridge near CETP Unnao along with effluent standards are given in Table 7.2.

Table 7.2 Characteristics of Effluents in UPSIDC Drain and Sewage Drain Near CETP Unnao

S.No.	Parameters	UPSIDC Drain (SW-5)		Sewage Drain (SW-6)		Effluent Standards
		Pre-monsoon	Post-monsoon	Pre-monsoon	Post-monsoon	
1.	pH	7.5	7.5	7.9	7.6	5.5-9.0
2.	TSS, mg/L	455	-	60	-	100
3.	Iron, mg/L	1.95	-	1.09	-	3
4.	Manganese, mg/L	0.26	-	0.68	-	2
5.	Copper, mg/L	0.01	0.04	0.01	0.04	3
6.	Nickel, mg/L	0.03	0.02	0.15	0.02	3
7.	Lead, mg/L	0.08	0.05	ND	0.02	0.1
8.	Cadmium, mg/L	ND	ND	ND	ND	2
9.	Zinc, mg/L	0.15	0.08	0.07	0.07	5
10.	Chromium (VI), mg/L	0.03	ND	0.02	ND	0.1
11.	Total Chromium, mg/L	0.85	1.61	0.09	0.34	2
12.	Arsenic, mg/L	-	0.05	-	0.11	0.2
13.	Nitrate-N, mg/L	1.13	2.37	0.90	7.9	10
14.	Phosphate-P, mg/L	ND	2.63	ND	5.73	5
15.	Fluoride, mg/L	-	1.6	-	2.6	2
16.	COD, mg/L	1752	780	220	425	250
17.	BOD, mg/L	1012	353	108	215	30

The effluent carried by UPSIDC drain is discharged by the industries after treatment as informed by UPPCB, Unnao. However, it is evident from the results that values of TSS, COD and BOD are not in conformity with the effluent standards notified vide G.S.R. 422(E) dated 19.5.1993 under Environment (Protection) Act, 1986 for discharge of effluent into inland surface water and needs appropriate statutory action by UPPCB/CPCB.

The analysis results of sewage drain joining Loni Drain at Kanpur – Unnao National Highway indicates that the values of phosphate, fluoride, COD and BOD are not in conformity with the effluent standards notified vide G.S.R. 422(E) dated 19.5.1993 under Environment (Protection) Act, 1986 for discharge of effluent into inland surface water and needs appropriate action by the concerned authorities. Health impacts of various contaminants are given in Annex – VIII.

7.1.3 Characteristics of Effluent in Loni Drain

The characteristics of effluents at different locations in Loni Drain along with effluent standards are given in Table 7.3.

Table 7.3 Characteristics of Effluents at Different Locations in Loni Drain

S.No.	Parameters	U/S of CETP (SW-3)		D/S of CETP (SW-4)		D/S of NH Bridge (SW-7)		Effluent Standards
		Pre-monsoon	Post-monsoon	Pre-monsoon	Post-monsoon	Pre-monsoon	Post-monsoon	
1.	pH	7.9	7.9	7.7	7.8	7.7	7.6	5.5-9.0
2.	TSS, mg/L	170	-	615	-	920	-	100
3.	Iron, mg/L	1.89	-	2.36	-	2.57	-	3
4.	Manganese, mg/L	0.65	-	0.27	-	0.03	-	2
5.	Copper, mg/L	0.02	0.07	0.03	0.11	0.02	0.03	3
6.	Nickel, mg/L	0.10	0.10	0.09	0.12	0.08	0.03	3
7.	Lead, mg/L	0.06	0.05	0.03	0.04	0.08	0.03	0.1
8.	Cadmium, mg/L	0.01	ND	0.01	ND	ND	ND	2
9.	Zinc, mg/L	0.11	0.18	0.08	0.10	0.03	0.41	5
10.	Chromium (VI), mg/L	0.02	0.01	0.02	ND	0.03	0.02	0.1
11.	Total Chromium, mg/L	0.45	0.54	1.04	0.37	0.06	1.66	2
12.	Arsenic, mg/L	-	0.07		0.09	-	0.09	0.2
13.	Nitrate-N, mg/L	ND	ND	3.8	ND	1.6	8.5	10
14.	Phosphate-P, mg/L	ND	4.72	ND	0.40	ND	2.19	5
15.	Fluoride, mg/L	-	1.4	-	1.5	-	2.2	2
16.	COD, mg/L	440	790	564	900	965	580	250
17.	BOD, mg/L	280	216	126	470	478	373	30

Loni Drain effluents are high in TSS, fluoride, COD and BOD and are not in conformity with the effluent standards notified vide G.S.R. 422(E) dated 19.5.1993 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water and needs appropriate statutory action by UPPCB/CPCB.

The Loni Drain carries sewage as well as industrial effluent to River Ganga. The waste water from this drain is also used by the farmers for irrigation. The drain is unlined and hence possibility of ground water contamination cannot be ruled out. Proper under ground sewage system must be laid in all inhabited areas and the untreated sewage and industrial wastes should not be allowed to flow in open drains. Health impacts of various contaminants are given in Annex – VIII.

7.1.4 Characteristics of Effluents at the Inlet and Outlet of CETP Banthar

The characteristics of effluent at the inlet and outlet of CETP Banthar along with effluent standards are given in Table 7.4.

Table 7.4 Effluent Characteristics at Inlet and Outlet of CETP Banthar

S.No.	Parameters	Inlet (SW-11)		Outlet (SW-12)		Effluent Standards
		Pre-monsoon	Post-monsoon	Pre-monsoon	Post-monsoon	
1.	pH	7.7	7.8	7.7	7.6	5.5-9.0
2.	TDS, mg/L	16484	10700	16058	10500	2100
3.	TSS, mg/L	990	-	265	-	100
4.	Copper, mg/L	0.18	0.14	0.02	0.07	3
5.	Nickel, mg/L	0.18	0.22	0.16	0.17	3
6.	Lead, mg/L	0.08	0.09	0.07	0.06	0.1
7.	Cadmium, mg/L	0.03	ND	0.02	ND	2
8.	Zinc, mg/L	0.08	0.07	0.04	0.04	5
9.	Total Chromium, mg/L	1.74	4.67	0.98	3.35	2
10.	Arsenic, mg/L	-	0.15	-	0.15	0.2
11.	Fluoride, mg/L	-	1.1	-	0.7	2
12.	COD, mg/L	2973	2300	683	2080	250
13.	BOD, mg/L	1011	1137	103	784	30

Analysis results of Banthar CETP samples indicate that the values of TDS, TSS, total chromium, COD and BOD are not in conformity with the effluent standards notified vide S.No. 55(B); G.S.R. 93(E) dated 21.2.1991 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water and needs appropriate statutory action by UPPCB/CPCB in order to avoid pollution of receiving water bodies. Health impacts of various contaminants are given in Annex - VIII.

Improvement in the quality of the effluent can be achieved through: i) Continuous operation of blowers for equalization tanks, ii) Continuous and appropriate recycling of activated sludge in both the aeration tanks, iii) Arresting escape of suspended solids from secondary clarifier, iv) Suspended solids escaping from the secondary clarifier should be trapped in tertiary clarifier by proper operation and v) Periodic performance audit.

7.1.5 Characteristics of Effluents in Banthar CETP Drain and UPSIDC Drain

The characteristics of effluents in Banthar CETP Drain and UPSIDC Drain along with effluent standards are given in Table 7.5.

Table 7.5 Characteristics of Effluents in Banthar CETP Drain (SW-8), UPSIDC Drain (SW-9) and UPSIDC Drain (SW-10)

S.No.	Parameters	Banthar CETP Drain (SW-8)		UPSIDC Drain (SW-9)		UPSIDC Drain (SW-10)		Effluent Standards
		Pre-monsoon	Post-monsoon	Pre-monsoon	Post-monsoon	Pre-monsoon	Post-monsoon	
1.	pH	7.8	-	7.5	8.0	7.2	7.8	5.5-9.0
2.	TSS, mg/L	410	-	605	-	455	-	100
3.	Iron, mg/L	1.00	-	1.86	-	0.89	-	3
4.	Manganese, mg/L	0.10	-	0.15	-	0.11	-	2
5.	Copper, mg/L	0.02	-	0.02	0.11	0.02	0.10	3
6.	Nickel, mg/L	0.02	-	0.02	0.04	0.04	0.07	3
7.	Lead, mg/L	0.03	-	ND	0.04	ND	0.04	0.1
8.	Cadmium, mg/L	0.02	-	ND	ND	ND	ND	2
9.	Zinc, mg/L	0.05	-	0.12	0.07	0.06	0.09	5
10.	Chromium (VI), mg/L	0.03	-	0.01	ND	0.02	0.02	0.1
11.	Total Chromium, mg/L	0.94	-	0.15	0.99	0.57	1.54	2
12.	Arsenic, mg/L		-	-	0.7	-	0.15	0.2
13.	Nitrate-N, mg/L	4.0	-	1.8	1.7	3.4	1.24	10
14.	Phosphate-P, mg/L	ND	-	ND	11.5	ND	0.74	5
15.	Fluoride, mg/L	-	-	-	1.2	-	1.0	2
16.	COD, mg/L	670	-	423	720	570	1620	250
17.	BOD, mg/L	95	-	216	176	160	607	30

Samples from UPSIDC drain before and after joining of Banthar CETP drain were high in TSS, COD and BOD and are not in conformity with the effluent standards notified vide G.S.R. 422(E) dated 19.5.1993 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water. Appropriate statutory action by UPPCB/CPCB is required against the industrial units discharging their effluent in Banthar and UPSIDC drain without treatment. Health impacts of various contaminants are given in Annex - VIII.

UPSIDC drain at Banthar meets City Jail Drain, water of which is being used by farmers for irrigation purpose. Pollutants concentration of such an extent in the drain water will lead to ground water pollution as well as affect crop productivity. Health impacts of various contaminants are given in Annex – VIII.

7.1.6 Characteristics of Effluents of M/s Mirja International Ltd.

The characteristics of effluents of M/s Mirja International Ltd. along with effluent standards are given in Table 7.6.

Table 7.6 Characteristics of Effluents of M/s Mirja International Ltd.

S.No.	Parameters	Inlet (SW-14)		Outlet (SW-15)		Effluent Standards
		Pre-monsoon	Post-monsoon	Pre-monsoon	Post-monsoon	
1.	pH	8.3	9.0	7.6	7.8	6.5-9.0
2.	TSS, mg/L	3130	-	200	-	100
3.	Total Chromium, mg/L	4.80	1.72	0.70	0.57	2
4.	BOD, mg/L	1313	352	45	314	30

Effluent discharged by M/s Mirja International Ltd. are not in conformity with the effluent standards notified vide S.No. 57; G.S.R. 475(E) dated 5.5.1992 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water for TSS and BOD and needs appropriate statutory action by UPPCB/CPCB.

7.1.7 Characteristics of Effluents of M/s Mustang Leather Pvt. Ltd.

The characteristics of effluents of M/s Mustang Leather Pvt. Ltd. along with effluent standards are given in Table 7.7.

Table 7.7 Characteristics of Effluents of M/s Mustang Leather Pvt. Ltd.

S.No.	Parameters	Inlet (SW-16)		Outlet (SW-17)		Effluent Standards
		Pre-monsoon	Post-monsoon	Pre-monsoon	Post-monsoon	
1.	pH	8.2	9.3	8.0	9.3	6.5-9.0
2.	TSS, mg/L	2200	-	310	-	100
3.	Total Chromium, mg/L	5.50	1.75	4.15	0.47	2
4.	BOD, mg/L	1138	744	71	588	30

Discharge from M/s Mustang Leather Pvt. Ltd. is high in pH, TSS, total chromium and BOD and exceed the limits notified vide S.No. 57; G.S.R. 475(E) dated 5.5.1992 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water and needs appropriate statutory action by UPPCB/CPCB.

7.1.8 Characteristics of Effluents of M/s Sadaf Enterprises Pvt. Ltd.

The characteristics of effluents of M/s Sadaf Enterprises Pvt. Ltd. along with effluent standards are given in Table 7.8.

Table 7.8 Characteristics of Effluents of M/s Sadaf Enterprises Pvt. Ltd.

S.No.	Parameters	Inlet (SW-18)		Outlet (SW-19)		Effluent Standards
		Pre-monsoon	Post-monsoon	Pre-monsoon	Post-monsoon	
1.	pH	7.7	10.8	6.7	7.6	6.5-9.0
2.	TSS, mg/L	550	-	145	-	100
3.	Total Chromium, mg/L	0.84	1.63	0.24	1.06	2
4.	BOD, mg/L	1313	824	24	98	30

The analysis results of the effluents discharged by M/s Sadaf Enterprises Pvt. Ltd. indicates that the values of TSS and BOD are not in conformity with the effluent standards notified vide S.No. 57; G.S.R. 475(E) dated 5.5.1992 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water and needs appropriate statutory action by UPPCB/CPCB.

7.1.9 Characteristics of Effluents of M/s Rehman Industries Ltd.

The characteristics of effluents of M/s Rehman Industries Ltd. along with effluent standards are given in Table 7.9.

Table 7.9 Characteristics of Effluents of M/s Rehman Industries Ltd.

S.No.	Parameters	Inlet (SW-20)		Outlet (SW-21)		Effluent Standards
		Pre-monsoon	Post-monsoon	Pre-monsoon	Post-monsoon	
1.	pH	8.4	8.5	7.5	7.5	6.5-9.0
2.	TSS, mg/L	2180	-	40	-	100
3.	Total Chromium, mg/L	1.15	1.65	0.23	0.58	2
4.	BOD, mg/L	1074	784	42	118	30

Effluent discharged by M/s Rehman Industries Ltd. do not conform to the effluent standards notified vide S.No. 57; G.S.R. 475(E) dated 5.5.1992 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water in respect of BOD and needs appropriate statutory action by UPPCB/CPCB.

7.1.10 Characteristics of Effluents of M/s Indagro Foods Ltd.

The characteristics of effluents of M/s Indagro Foods Ltd. along with effluent standards are given in Table 7.10.

Table 7.10 Characteristics of Effluents of M/s Indagro Foods Ltd.

S.No.	Parameters	Inlet (SW-23)		Outlet (SW-24)		Effluent Standards
		Pre-monsoon	Post-monsoon	Pre-monsoon	Post-monsoon	
1.	TSS, mg/L	1660	-	125	-	50
2.	BOD, mg/L	1401	1294	25	79	30

The dung dumping site of Indagro Foods Ltd. was full of waste from the factory which includes animal remains as well as sludge due to which foul odor was observed in the surroundings. Proper regulation of dumping waste is therefore desired.

The effluent discharged by M/s Indagro Foods Ltd. do not conform to the standards notified vide S.No. 50; G.S.R. 93(E) dated 21.2.1991 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water in respect of TSS and BOD and needs appropriate statutory action by UPPCB/CPCB.

7.1.11 Characteristics of Effluents of M/s AOV Exports Pvt. Ltd.

The characteristics of effluents of M/s AOV Exports Pvt. Ltd. along with effluent standards are given in Table 7.11.

Table 7.11 Characteristics of Effluents of M/s AOV Exports Pvt. Ltd.

S.No.	Parameters	Inlet (SW-25)		Outlet (SW-26)		Effluent Standards
		Pre-monsoon	Post-monsoon	Pre-monsoon	Post-monsoon	
1.	TSS, mg/L	-	-	275	-	50
2.	BOD, mg/L	-	1058	267	784	30

The analysis results of the effluents discharged by M/s AOB Exports Pvt. Ltd. indicates that the values of TSS and BOD are not in conformity with the effluent standards notified vide S.No. 50; G.S.R. 93(E) dated 21.2.1991 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water and needs appropriate statutory action by UPPCB/CPCB.

7.1.12 Characteristics of Effluents of Sewage Drain and City Jail Drain

The characteristics of effluents of Sewage Drain and City Jail Drain along with effluent standards are given in Table 7.12.

Table 7.12 Characteristics of Effluents of Sewage Drain and City Jail Drain

S.No.	Parameters	Sewage Drain (SW-22)		City Jail Drain (SW-13)		Effluent Standards
		Pre-monsoon	Post-monsoon	Pre-monsoon	Post-monsoon	
1.	pH	7.8	7.7	7.9	8.1	5.5-9.0
2.	TSS, mg/L	90	-	175	-	100
3.	Iron, mg/L	2.52	-	21.6	-	3
4.	Manganese, mg/L	0.23	-	1.43	-	2
5.	Copper, mg/L	0.02	0.03	0.02	0.03	3
6.	Nickel, mg/L	0.01	0.63	0.34	0.05	3
7.	Lead, mg/L	0.01	0.06	0.01	0.04	0.1
8.	Cadmium, mg/L	ND	ND	ND	ND	2
9.	Zinc, mg/L	0.27	0.06	0.15	0.13	5
10.	Chromium (VI), mg/L	0.01	ND	0.02	ND	0.1
11.	Total Chromium, mg/L	0.22	0.61	0.63	1.54	2
12.	Arsenic, mg/L	-	0.09	-	0.12	0.2
13.	Nitrate-N, mg/L	4.1	1.41	5.0	1.13	10
14.	Phosphate-P, mg/L	4.0	0.84	ND	4.31	5
15.	Fluoride, mg/L	-	3.2	-	1.2	2
16.	COD, mg/L	160	600	256	640	250
17.	BOD, mg/L	41	490	69	215	30

The analysis results of sewage drain indicates that the values of fluoride, COD and BOD are not in conformity with the effluent standards notified vide G.S.R. 422(E) dated 19.5.1993 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water and needs appropriate action by concerned authorities.

The analysis results of City Jail Drain indicates that the values of TSS, iron, COD and BOD are not in conformity with the effluent standards notified vide G.S.R. 422(E) dated 19.5.1993 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water and needs appropriate statutory action by UPPCB/CPCB.

Both Sewage Dain and the City Jail Drain transports sewage as well as industrial effluent to River Ganga through open drains and therefore possibilities of ground water contamination cannot be ruled out. Proper under ground sewage system must be laid in all inhabited areas and the untreated sewage and industrial wastes should not be allowed to flow in open drains. Health impacts of various contaminants are given in Annex – VIII.

7.1.13 Characteristics of Effluents of M/s Omega International

The characteristics of effluents of M/s Omega International along with effluent standards are given in Table 7.13.

Table 7.13 Characteristics of Effluents of M/s Omega International (Post-monsoon)

S.No.	Parameters	Inlet (SW-27)	Outlet (SW-28)	Effluent Standards
1.	pH	8.5	7.2	6.5-9.0
2.	Total Chromium, mg/L	1.84	1.79	2
3.	BOD, mg/L	392	353	30

Effluent discharged by M/s Omega International do not conform to the effluent standards notified vide S.No. 57; G.S.R. 475(E) dated 5.5.1992 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water in respect of BOD and needs appropriate statutory action by UPPCB/CPCB.

7.1.14 Characteristics of Effluents of M/s Allied Leather Finishers Pvt. Ltd.

The characteristics of effluents of M/s Allied Leather Finishers Pvt. Ltd. along with effluent standards are given in Table 7.14.

Table 7.14 Characteristics of Effluents of M/s Allied Leather Finishers Pvt. Ltd. (Post-monsoon)

S.No.	Parameters	Inlet (SW-29)	Outlet (SW-30)	Effluent Standards
1.	pH	6.7	7.7	6.5-9.0
2.	Total Chromium, mg/L	35.60	14.7	2
3.	BOD, mg/L	333	294	30

Effluent discharged by M/s Allied Leather Finishers Pvt. Ltd. do not conform to the effluent standards notified vide S.No. 57; G.S.R. 475(E) dated 5.5.1992 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water in respect of total chromium and BOD and needs appropriate statutory action by UPPCB/CPCB.

7.1.15 Characteristics of Effluents of M/s Rustam Food Pvt. Ltd.

The characteristics of effluents of M/s Rustam Food Pvt. Ltd. along with effluent standards are given in Table 7.15.

Table 7.15 Characteristics of Effluents of M/s Rustam Food Pvt. Ltd. (Post-monsoon)

S.No.	Parameters	Inlet (SW-31)	Outlet (SW-32)	Effluent Standards
1.	BOD, mg/L	79	59	30

Effluent discharged by M/s Rustam Food Pvt. Ltd. do not conform to the effluent standards notified vide G.S.R. 422(E) dated 19.5.1993 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water in respect of BOD and needs appropriate statutory action by UPPCB/CPCB.

7.1.16 Characteristics of Combined Effluents of M/s Falak Enterprises and M/s Asharfi Agro Byproducts

The characteristics of combined effluents of M/s Falak Enterprises and M/s Asharfi Agro Byproducts along with effluent standards are given in Table 7.16.

Table 7.16 Characteristics of Combined Effluents of M/s Falak Enterprises and M/s Asharfi Agro Byproducts (Post-monsoon)

S.No.	Parameters	Inlet (SW-33)	Outlet (SW-34)	Effluent Standards
1.	pH	6.8	7.9	5.5-9.0
2.	Copper, mg/L	0.14	0.06	3
3.	Nickel, mg/L	0.03	0.03	3
4.	Lead, mg/L	0.02	ND	0.1
5.	Cadmium, mg/L	ND	ND	2
6.	Zinc, mg/L	0.11	0.06	5
7.	Chromium (VI), mg/L	0.11	ND	0.1
8.	Total Chromium, mg/L	7.69	0.99	2
9.	Arsenic, mg/L	0.19	0.09	0.2
10.	Nitrate-N, mg/L	4.66	4.63	10
11.	Phosphate-P, mg/L	11.3	5.7	5
12.	Fluoride, mg/L	3.2	2.6	2
13.	COD, mg/L	2700	450	250
14.	BOD, mg/L	862	353	30

Combined effluent discharged by M/s Falak Enterprises and M/s Asharfi Agro Byproducts do not conform to the effluent standards notified vide G.S.R. 422(E) dated 19.5.1993 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water in respect of phosphate, fluoride, COD and BOD and needs appropriate statutory action by UPPCB/CPCB.

7.1.17 Characteristics of Effluents of M/s Resinova Chemicals

The characteristics of effluents of M/s Resinova Chemicals along with effluent standards are given in Table 7.17.

Table 7.17 Characteristics of Effluents of M/s Resinova Chemicals (Post-monsoon)

S.No.	Parameters	Inlet (SW-35)	Outlet (SW-36)	Effluent Standards
1.	pH	8.6	7.2	5.5-9.0
2.	Copper, mg/L	0.11	0.07	3
3.	Nickel, mg/L	0.04	0.04	3
4.	Lead, mg/L	0.05	0.03	0.1
5.	Cadmium, mg/L	ND	ND	2
6.	Zinc, mg/L	0.08	0.07	5
7.	Chromium (VI), mg/L	ND	ND	0.1
8.	Total Chromium, mg/L	1.49	0.85	2
9.	Arsenic, mg/L	0.15	0.09	0.2
10.	Nitrate-N, mg/L	7.9	3.73	10
11.	Phosphate-P, mg/L	0.84	0.74	5
12.	Fluoride, mg/L	5.0	3.6	2
13.	COD, mg/L	2360	2200	250
14.	BOD, mg/L	706	626	30

Effluent discharged by M/s Resinova Chemicals do not conform to the effluent standards notified vide G.S.R. 422(E) dated 19.5.1993 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water in respect of COD and BOD and needs appropriate statutory action by UPPCB/CPCB.

7.1.18 Characteristics of Effluents of M/s Handloom Bhandar

The characteristics of effluents of M/s Handloom Bhandar along with effluent standards are given in Table 7.18.

Table 7.18 Characteristics of Effluents of M/s Handloom Bhandar (Post-monsoon)

S.No.	Parameters	Inlet (SW-37)	Outlet (SW-38)	Effluent Standards
1.	pH	8.7	7.0	5.5-9.0
2.	Total Chromium, mg/L	1.67	1.33	2
3.	COD, mg/L	1960	710	250
4.	BOD, mg/L	666	353	30

Effluent discharged by M/s Handloom Bhandar do not conform to the effluent standards notified vide S.No. 92; G.S.R. 742(E) dated 25.9.2000 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water in respect of COD and BOD and needs appropriate statutory action by UPPCB/CPCB.

7.1.19 Characteristics of Effluents of Rimjhim Stainless Ltd. (Formerly Global Smelters)

The characteristics of effluents of M/s Rimjhim Stainless Ltd. (Formerly Global Smelters) along with effluent standards are given in Table 7.19.

Table 7.19 Characteristics of Effluents of M/s Rimjhim Stainless Ltd. (Formerly Global Smelters) (Post-monsoon)

S.No.	Parameters	Inlet	Outlet (SW-39)	Effluent Standards
1.	pH	-	11.2	6.0-9.0
2.	Copper, mg/L	-	0.22	3
3.	Nickel, mg/L	-	0.11	3
4.	Lead, mg/L	-	0.53	0.1
5.	Cadmium, mg/L	-	ND	2
6.	Zinc, mg/L	-	0.15	5
7.	Chromium (VI), mg/L	-	0.02	0.1
8.	Total Chromium, mg/L	-	0.64	2
9.	Fluoride, mg/L	-	270*	-

* Although the fluoride is not prescribed in the standards, but the value of fluoride is alarmingly high and needs attention.

Effluent discharged by M/s Rimjhim Stainless Ltd. (Formerly Global Smelters) do not conform to the effluent standards notified vide S.No. 9; G.S.R. 393(E) dated 16.4.1987 and S.No. 30; GSR 913(E) dated 24.10.1989 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water in respect of pH, lead, total chromium, COD and BOD and needs appropriate statutory action by UPPCB/CPCB.

7.1.20 Characteristics of Effluents of M/s Bajaj Kagaj Udyog Ltd.

The characteristics of effluents of M/s Bajaj Kagaj Udyog Ltd. along with effluent standards are given in Table 7.20.

Table 7.20 Characteristics of Effluents of M/s Bajaj Kagaj Udyog Ltd. (Post-monsoon)

S.No.	Parameters	Inlet (SW-40)	Outlet (SW-41)	Effluent Standards
1.	pH	8.0	7.3	5.5-9.0
2.	Copper, mg/L	0.16	0.03	3
3.	Nickel, mg/L	0.02	0.03	3
4.	Lead, mg/L	0.01	ND	0.1
5.	Cadmium, mg/L	ND	ND	2
6.	Zinc, mg/L	0.54	0.12	5
7.	Chromium (VI), mg/L	ND	ND	0.1
8.	Total Chromium, mg/L	0.77	0.44	2
9.	Arsenic, mg/L	0.12	0.09	0.2
10.	Nitrate-N, mg/L	1.13	0.45	10
11.	Phosphate-P, mg/L	1.65	0.17	5
12.	Fluoride, mg/L	1.6	1.4	2
13.	COD, mg/L	220	100	250
14.	BOD, mg/L	88	59	30

Effluent discharged by M/s Bajaj Kagaj Udyog Ltd. do not conform to the effluent standards notified vide G.S.R. 422(E) dated 19.5.1993 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water in respect of BOD and needs appropriate statutory action by UPPCB/CPCB.

7.1.21 Characteristics of Effluents of M/s J. S. International

The characteristics of effluents of M/s J. S. International along with effluent standards are given in Table 7.21.

Table 7.21 Characteristics of Effluents of M/s J. S. International (Post-monsoon)

S.No.	Parameters	Inlet (SW-42)	Outlet (SW-43)	Effluent Standards
1.	BOD, mg/L	902	216	30

Effluent discharged by M/s J. S. International do not conform to the effluent standards notified vide S.No. 50; G.S.R. 93(E) dated 21.2.1991 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water in respect of BOD and needs appropriate statutory action by UPPCB/CPCB.

7.1.22 Characteristics of Effluents of M/s Mahavir Spin Fabrics

The characteristics of effluents of M/s Mahavir Spin Fabrics along with effluent standards are given in Table 7.22.

Table 7.22 Characteristics of Effluents of M/s Mahavir Spin Fabrics (Post-monsoon)

S.No.	Parameters	Inlet (SW-44)	Outlet (SW-45)	Effluent Standards
1.	pH	8.6	7.4	5.5-9.0
2.	Total Chromium, mg/L	0.71	0.63	2
3.	COD, mg/L	1960	830	250
4.	BOD, mg/L	1020	451	30

Effluent discharged by M/s Mahavir Spin Fabrics do not conform to the effluent standards notified vide S.No. 92; G.S.R. 742(E) dated 25.9.2000 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water in respect of COD and BOD and needs appropriate statutory action by UPPCB/CPCB.

7.1.23 Characteristics of Effluents of M/s Balaji Industries Ltd.

The characteristics of effluents of M/s Balaji Industries Ltd. along with effluent standards are given in Table 7.23.

Table 7.23 Characteristics of Effluents of M/s Balaji Industries Ltd. (Post-monsoon)

S.No.	Parameters	Inlet	Outlet (SW-46)	Effluent Standards
1.	pH	-	6.9	5.5-9.0
2.	Total Chromium, mg/L	-	0.68	2
3.	COD, mg/L	-	1520	250
4.	BOD, mg/L	-	275	30

Effluent discharged by M/s Balaji Industries Ltd. do not conform to the effluent standards notified vide S.No. 92; G.S.R. 742(E) dated 25.9.2000 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water in respect of COD and BOD and needs appropriate statutory action by UPPCB/CPCB.

7.1.24 Characteristics of Effluents of M/s ACI Oils Ltd.

The characteristics of effluents of M/s ACI Oils Pvt. Ltd. along with effluent standards are given in Table 7.24.

Table 7.24 Characteristics of Effluents of M/s ACI Oils Pvt. Ltd. (Post-monsoon)

S.No.	Parameters	Inlet (SW-47)	Outlet (SW-48)	Effluent Standards
1.	pH	7.3	7.9	6.5-8.5
2.	COD, mg/L	1740	760	200
3.	BOD, mg/L	314	157	100

Effluent discharged by M/s ACI Oils Pvt. Ltd. do not conform to the effluent standards notified vide S.No. 67; G.S.R. 176(E) dated 2.4.1996 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water in respect of COD and BOD and needs appropriate statutory action by UPPCB/CPCB.

7.1.25 Characteristics of Effluents of M/s Jeet Dyeing Industries

The characteristics of effluents of M/s Jeet Dyeing Industries along with effluent standards are given in Table 7.25.

Table 7.25 Characteristics of Effluents of M/s Jeet Dyeing Industries (Post-monsoon)

S.No.	Parameters	Inlet (SW-49)	Outlet (SW-50)	Effluent Standards
1.	pH	7.1	7.1	5.5-9.0
2.	Total Chromium, mg/L	0.39	0.33	2
3.	COD, mg/L	1820	1100	250
4.	BOD, mg/L	392	274	30

Effluent discharged by M/s Jeet Dyeing Industries do not conform to the effluent standards notified vide S.No. 92; G.S.R. 742(E) dated 25.9.2000 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water in respect of COD and BOD and needs appropriate statutory action by UPPCB/CPCB.

7.1.26 Characteristics of Effluents of M/s Sadaf Dyeing and Proofing

The characteristics of effluents of M/s Sadaf Dyeing and Proofing along with effluent standards are given in Table 7.26.

Table 7.26 Characteristics of Effluents of M/s Sadaf Dyeing and Proofing (Post-monsoon)

S.No.	Parameters	Inlet (SW-51)	Outlet (SW-52)	Effluent Standards
1.	pH	7.3	7.3	5.5-9.0
2.	Total Chromium, mg/L	0.59	0.38	2
3.	COD, mg/L	1780	1000	250
4.	BOD, mg/L	353	352	30

Effluent discharged by M/s Sadaf Dyeing and Proofing do not conform to the effluent standards notified vide S.No. 92; G.S.R. 742(E) dated 25.9.2000 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water in respect of COD and BOD and needs appropriate statutory action by UPPCB/CPCB.

7.1.27 Characteristics of Effluents of M/s Universal Yarn and Textile Pvt. Ltd.

The characteristics of effluents of M/s Universal Yarn and Textile Pvt. Ltd. along with effluent standards are given in Table 7.27.

Table 7.27 Characteristics of Effluents of M/s Universal Yarn and Textile Pvt. Ltd. (Post-monsoon)

S.No.	Parameters	Inlet (SW-53)	Outlet (SW-54)	Effluent Standards
1.	pH	9.3	8.9	5.5-9.0
2.	Total Chromium, mg/L	0.63	0.28	2
3.	COD, mg/L	1250	1080	250
4.	BOD, mg/L	274	235	30

Effluent discharged by M/s Universal Yarn and Textile Pvt. Ltd. do not conform to the effluent standards notified vide S.No. 92; G.S.R. 742(E) dated 25.9.2000 under Environment (Protection) Act, 1986 for discharge of effluents into inland surface water in respect of COD and BOD and needs appropriate statutory action by UPPCB/CPCB.

7.2 Ground Water Quality

In order to see the impact of various industrial effluents on ground water quality, seven ground water samples (G-1 to G-7) in pre-monsoon season and fifty three ground water samples (G-1 to G-2 & G-5 to G-55) in post-monsoon season were collected and analyzed for various physico-chemical parameters and metal ions (Table 7.28a&b). Drinking water specifications prescribed by BIS are given in Annex – X. The values indicated in red colours exceed the maximum permissible limit for drinking water.

Table 7.28(a) Physico-chemical Characteristics of Ground Water (Pre-monsoon)

S.No.	Parameters	G-1	G-2	G-3	G-4	G-5	G-6	G-7
1.	pH	7.7	7.6	7.9	7.8	6.8	6.9	7.3
2.	EC, µS/cm	1614	895	3569	3984	8902	3524	746
3.	TDS, mg/L	1033	573	2284	2550	5697	2255	477
4.	Alkalinity, mg/L	440	420	400	250	408	350	340
5.	Hardness, mg/L	270	239	167	900	2200	1160	224
6.	Chloride, mg/L	325	146	212	180	2076	1444	113
7.	Sulphate, mg/L	28	9	720	1580	1724	430	104
8.	Nitrate, mg/L	ND	ND	ND	ND	ND	ND	ND
9.	Sodium, mg/L	178	75	522	208	348	213	72
10.	Potassium, mg/L	4.7	4.5	6.2	10	19	25	4.9
11.	Calcium, mg/L	72	61	19	208	540	298	48
12.	Magnesium, mg/L	22	21	29	92	204	100	25
13.	Iron, mg/L	0.54	0.90	1.60	1.70	5.50	17	0.83
14.	Manganese, mg/L	0.04	0.53	0.02	1.99	0.95	0.96	0.04
15.	Copper, mg/L	0.02	0.01	0.02	0.04	0.03	0.04	0.01
16.	Nickel, mg/L	ND	ND	0.11	0.14	0.29	0.01	ND
17.	Lead, mg/L	ND	ND	ND	0.01	0.03	ND	ND
18.	Cadmium, mg/L	ND	ND	ND	ND	ND	ND	ND
19.	Zinc, mg/L	0.11	0.18	0.38	0.17	0.05	1.30	1.44
20.	Chromium (VI), mg/L	0.01	0.09	0.01	4.24	0.27	0.01	0.01

Table 7.28(b) Physico-chemical Characteristics of Ground Water (Post-monsoon)

S.No.	Parameters	G-1	G-2	G-3	G-4	G-5	G-6	G-7
1.	pH	8.12	7.79	-	-	7.92	7.04	7.53
2.	EC, µS/cm	636	636	-	-	7100	3550	850
3.	TDS, mg/L	407	407	-	-	4544	2272	544
4.	Alkalinity, mg/L	335	300	-	-	330	690	360
5.	Hardness, mg/L	220	225	-	-	1750	875	280
6.	Chloride, mg/L	14	11	-	-	1420	433	39
7.	Sulphate, mg/L	3.0	9.0	-	-	1056	384	32
8.	Nitrate, mg/L	3.7	0.2	-	-	0.6	7.4	6.2
9.	Fluoride, mg/L	0.51	0.48	-	-	0.45	2.30	0.87
10.	Sodium, mg/L	63	43	-	-	805	391	78
11.	Potassium, mg/L	3.6	4.5	-	-	15	15	3.1
12.	Calcium, mg/L	38	44	-	-	412	168	46
13.	Magnesium, mg/L	30	28	-	-	175	111	40
14.	Iron, mg/L	0.091	0.083	-	-	0.490	0.822	0.033
15.	Manganese, mg/L	0.072	0.042	-	-	0.081	0.176	0.279
16.	Copper, mg/L	0.018	0.006	-	-	0.022	0.017	0.009
17.	Lead, mg/L	0.050	0.047	-	-	0.090	0.087	0.053
18.	Zinc, mg/L	0.528	0.191	-	-	0.227	0.334	0.447
19.	Chromium (VI), mg/L	0.003	0.002	-	-	0.004	0.010	ND

Table 7.28(b) Contd.

S.No.	Parameters	G-8	G-9	G-10	G-11	G-12	G-13	G-14
1.	pH	7.03	6.95	7.33	7.41	7.82	7.99	8.11
2.	EC, µS/cm	1856	2187	2197	1231	831	716	832
3.	TDS, mg/L	1188	1400	1406	788	532	458	532
4.	Alkalinity, mg/L	690	560	560	415	355	330	380
5.	Hardness, mg/L	375	710	570	310	220	275	250
6.	Chloride, mg/L	99	291	234	35	14	25	50
7.	Sulphate, mg/L	105	155	82	103	37	26	19
8.	Nitrate, mg/L	0.0	79	94	15	0.1	5.5	5.6
9.	Fluoride, mg/L	0.67	0.96	1.13	0.69	0.54	0.41	0.67
10.	Sodium, mg/L	257	218	208	124	87	53	102
11.	Potassium, mg/L	4.1	8.6	23	3.9	3.2	4.8	1.9
12.	Calcium, mg/L	76	112	102	46	34	42	30
13.	Magnesium, mg/L	44	103	76	47	32	41	42
14.	Iron, mg/L	0.116	0.050	0.058	0.058	0.083	0.041	0.074
15.	Manganese, mg/L	0.098	0.115	0.068	0.076	0.111	0.046	0.063
16.	Copper, mg/L	0.013	0.012	0.008	0.007	0.007	0.006	0.009
17.	Lead, mg/L	0.081	0.022	0.066	0.038	0.029	0.044	0.041
18.	Zinc, mg/L	0.608	0.247	0.951	0.111	0.225	0.191	0.180
19.	Chromium (VI), mg/L	0.010	0.001	0.005	ND	0.679	0.023	0.015

Table 7.28(b) Contd.

S.No.	Parameters	G-15	G-16	G-17	G-18	G-19	G-20	G-21
1.	pH	8.19	8.20	8.01	7.54	8.04	7.67	7.33
2.	EC, µS/cm	706	610	550	944	533	859	1515
3.	TDS, mg/L	452	390	352	604	341	550	970
4.	Alkalinity, mg/L	330	245	255	315	275	380	370
5.	Hardness, mg/L	260	215	190	255	205	270	595
6.	Chloride, mg/L	18	21	14	71	7	28	344
7.	Sulphate, mg/L	36	9	15	25	12	28	64
8.	Nitrate, mg/L	11	14	0.7	2.8	0.0	0.0	16
9.	Fluoride, mg/L	0.61	0.33	0.53	0.56	0.46	0.33	0.95
10.	Sodium, mg/L	62	6	44	83	40	79	154
11.	Potassium, mg/L	5.0	53	4.3	5.8	4.5	5.9	3.6
12.	Calcium, mg/L	46	34	50	72	34	64	62
13.	Magnesium, mg/L	35	31	16	18	29	26	106
14.	Iron, mg/L	0.066	0.016	0.008	0.050	0.141	0.174	0.083
15.	Manganese, mg/L	0.042	0.098	0.089	0.400	0.012	0.081	0.158
16.	Copper, mg/L	0.029	0.004	0.004	0.010	0.005	0.009	0.010
17.	Lead, mg/L	0.047	0.033	0.023	0.057	0.032	0.060	0.050
18.	Zinc, mg/L	0.436	0.015	0.351	0.185	0.138	0.260	0.120
19.	Chromium (VI), mg/L	0.003	0.005	0.006	0.007	0.004	ND	ND

Table 7.28(b) Contd.

S.No.	Parameters	G-22	G-23	G-24	G-25	G-26	G-27	G-28
1.	pH	7.45	7.70	7.43	7.17	7.20	7.72	7.63
2.	EC, µS/cm	1325	975	984	762	3883	949	1040
3.	TDS, mg/L	848	624	630	488	2485	607	666
4.	Alkalinity, mg/L	430	380	340	310	660	380	365
5.	Hardness, mg/L	300	240	250	260	860	355	400
6.	Chloride, mg/L	67	18	46	50	652	14	92
7.	Sulphate, mg/L	214	128	116	20	60	10	10
8.	Nitrate, mg/L	0.0	0.0	2.7	37	107	2.6	4.0
9.	Fluoride, mg/L	0.92	0.78	0.41	0.96	0.38	0.56	0.74
10.	Sodium, mg/L	204	135	125	78	396	28	48
11.	Potassium, mg/L	3.3	3.8	5.1	4.7	6.0	4.1	2.5
12.	Calcium, mg/L	38	34	46	44	120	36	56
13.	Magnesium, mg/L	49	37	32	36	134	64	62
14.	Iron, mg/L	0.141	0.074	0.141	0.033	0.108	0.025	0.074
15.	Manganese, mg/L	0.206	0.210	0.314	0.227	0.141	0.085	0.094
16.	Copper, mg/L	0.008	0.008	0.010	0.007	0.022	0.006	0.004
17.	Lead, mg/L	0.060	0.057	0.047	0.035	0.102	0.035	0.038
18.	Zinc, mg/L	0.429	0.824	0.750	0.296	0.080	0.075	0.253
19.	Chromium (VI), mg/L	ND	0.007	0.001	0.002	0.922	0.023	ND

Table 7.28(b) Physico-chemical Characteristics of Ground Water (Post-monsoon)

S.No.	Parameters	G-29	G-30	G-31	G-32	G-33	G-34	G-35
1.	pH	7.63	7.50	7.68	7.69	7.74	7.13	8.03
2.	EC, µS/cm	1164	1607	703	820	652	785	1784
3.	TDS, mg/L	745	1028	450	525	417	502	1142
4.	Alkalinity, mg/L	490	450	210	400	320	380	563
5.	Hardness, mg/L	360	420	280	320	285	190	430
6.	Chloride, mg/L	64	220	50	28	35	14	149
7.	Sulphate, mg/L	20	20	15	10	10	10	30
8.	Nitrate, mg/L	4.3	23	39	5.0	6.6	63	7.2
9.	Fluoride, mg/L	0.47	0.67	0.39	0,82	0.69	1.17	1.29
10.	Sodium, mg/L	109	170	20	62	44	124	172
11.	Potassium, mg/L	4.9	6.1	3.0	4.4	4.1	3.4	7.3
12.	Calcium, mg/L	48	64	64	48	48	28	44
13.	Magnesium, mg/L	58	62	48	62	40	29	77
14.	Iron, mg/L	0.083	0.074	0.224	0.058	0.116	0.083	0.058
15.	Manganese, mg/L	0.227	0.223	0.133	0.094	0.124	0.068	0.137
16.	Copper, mg/L	0.013	0.008	0.010	0.009	0.007	0.008	0.012
17.	Lead, mg/L	0.047	0.057	0.038	0.032	0.042	0.029	0.015
18.	Zinc, mg/L	0.902	0.066	0.599	0.078	1.056	0.585	0.062
19.	Chromium (VI), mg/L	ND	ND	ND	ND	0.002	0.010	ND

Table 7.28(b) Contd.

S.No.	Parameters	G-36	G-37	G-38	G-39	G-40	G-41	G-42
1.	pH	7.75	7.98	8.00	7.91	7.82	7.83	8.04
2.	EC, µS/cm	1730	1123	948	827	1023	1699	1607
3.	TDS, mg/L	1107	719	607	529	655	1087	1028
4.	Alkalinity, mg/L	540	460	400	300	430	490	595
5.	Hardness, mg/L	555	230	210	365	380	400	570
6.	Chloride, mg/L	163	28	64	57	71	163	92
7.	Sulphate, mg/L	20	10	10	10	20	40	40
8.	Nitrate, mg/L	18	6.7	0.0	104	7.2	18	6.7
9.	Fluoride, mg/L	0.73	1.32	1.41	1.20	0.95	0.65	0.79
10.	Sodium, mg/L	89	131	137	49	74	169	118
11.	Potassium, mg/L	47	3.0	6.0	4.1	4.4	7.2	7.0
12.	Calcium, mg/L	72	28	40	56	56	76	72
13.	Magnesium, mg/L	90	38	26	54	58	50	79
14.	Iron, mg/L	0.050	0.058	0.074	0.224	0.050	0.074	0.166
15.	Manganese, mg/L	0.167	0.094	0.145	0.085	0.012	0.094	0.154
16.	Copper, mg/L	0.013	0.007	0.007	0.008	0.008	0.008	0.011
17.	Lead, mg/L	0.011	0.029	0.030	0.050	0.026	0.041	0.047
18.	Zinc, mg/L	0.055	0.338	0.113	0.367	0.091	0.069	0.467
19.	Chromium (VI), mg/L	ND	ND	ND	ND	ND	ND	ND

Table 7.28(b) Physico-chemical Characteristics of Ground Water (Post-monsoon)

S.No.	Parameters	G-43	G-44	G-45	G-46	G-47	G-48	G-49
1.	pH	7.89	8.02	7.58	8.44	8.26	8.23	8.42
2.	EC, µS/cm	1040	4213	1180	1050	2930	1850	1260
3.	TDS, mg/L	666	2696	755	672	1875	1184	806
4.	Alkalinity, mg/L	370	1020	466	330	570	360	280
5.	Hardness, mg/L	115	1210	390	50	750	460	350
6.	Chloride, mg/L	50	560	57	92	412	227	135
7.	Sulphate, mg/L	30	216	19	ND	240	182	72
8.	Nitrate, mg/L	0.0	104	5.0	ND	6.2	3.1	ND
9.	Fluoride, mg/L	1.13	0.80	0.95	2.15	1.45	1.15	0.95
10.	Sodium, mg/L	163	396	81	207	299	196	115
11.	Potassium, mg/L	1.6	13	8.6	3.1	25	7.8	5.8
12.	Calcium, mg/L	20	200	64	12	128	108	76
13.	Magnesium, mg/L	16	170	556	4.9	105	46	39
14.	Iron, mg/L	0.074	0.133	0.083	0.099	0.166	0.448	0.207
15.	Manganese, mg/L	0.076	0.150	0.076	0.042	0.150	0.193	0.089
16.	Copper, mg/L	0.010	0.023	0.010	0.010	0.023	0.018	0.013
17.	Lead, mg/L	0.005	0.087	0.020	0.023	0.048	0.069	0.030
18.	Zinc, mg/L	0.009	0.169	0.363	0.002	0.049	0.376	0.278
19.	Chromium (VI), mg/L	0.002	0.002	ND	ND	ND	0.004	ND

Table 7.28(b) Contd.

S.No.	Parameters	G-50	G-51	G-52	G-53	G-54	G-55
1.	pH	8.25	7.90	8.11	8.25	8.67	8.25
2.	EC, µS/cm	1150	2450	1700	850	1500	4650
3.	TDS, mg/L	736	1568	1088	544	960	2976
4.	Alkalinity, mg/L	310	410	380	320	590	330
5.	Hardness, mg/L	330	680	460	340	100	1400
6.	Chloride, mg/L	124	284	185	43	28	568
7.	Sulphate, mg/L	48	336	144	ND	ND	1080
8.	Nitrate, mg/L	5.0	4.3	20	3.1	8.7	ND
9.	Fluoride, mg/L	0.70	0.40	0.50	0.75	4.90	0.90
10.	Sodium, mg/L	69	235	140	25	285	403
11.	Potassium, mg/L	50	8.6	50	5.0	5.5	9.7
12.	Calcium, mg/L	80	164	112	92	16	256
13.	Magnesium, mg/L	32	66	44	27	15	185
14.	Iron, mg/L	0.306	0.390	0.199	0.207	0.050	0.639
15.	Manganese, mg/L	0.214	0.292	0.171	0.210	0.106	0.215
16.	Copper, mg/L	0.187	0.020	0.016	0.024	0.011	0.023
17.	Lead, mg/L	0.050	0.060	0.020	0.035	0.023	0.087
18.	Zinc, mg/L	2.160	1.782	0.129	0.385	0.133	5.212
19.	Chromium (VI), mg/L	0.007	ND	ND	ND	0.007	ND

7.2.1 General Characteristics

The pH values in the collected ground water samples of study area fall within the range 6.8 to 7.9 during pre-monsoon and 7.0 to 8.7 during post-monsoon. The pH values for almost all of the samples are well within the limits prescribed by BIS (1991) and WHO (1996) for various uses of water including drinking and other domestic supplies.

The electrical conductivity and dissolved salt concentrations are directly related to the concentration of ionized substance in water and may also be related to problems of excessive hardness and/or other mineral contamination. The conductivity values in the ground water samples of the study area vary from 746 to 8902 µS/cm during pre-monsoon season with most of the samples having conductivity value above 1000 µS/cm and 533 to 7100 µS/cm during post-monsoon season with more than 50% of the samples having conductivity value above 1000 µS/cm. The maximum conductivity value of 8092 µS/cm was observed in the hand pump of village Dakari, which may be attributed to leaching of waste generated from biofertilizer units.

The TDS values in the ground water varies from 477 to 5697 mg/L during pre-monsoon season and 341 to 4544 mg/L during post-monsoon season with most of the samples having TDS values above the desirable limit of 500 mg/L. Water containing more than 500 mg/L of TDS is not considered desirable for drinking water supplies, though more highly mineralized water is also used where better water is not available. For this reason, 500 mg/L as the desirable limit and 2000 mg/L as the maximum permissible limit has been suggested for drinking water (BIS, 1991). Water containing TDS more than 500 mg/L causes gastrointestinal irritation (BIS, 1991).

Alkalinity in natural water is mainly due to presence of carbonates, bicarbonates and hydroxides. Bicarbonates represent the major form since they are formed in considerable amount from the action of carbonates upon the basic materials in the soil. The alkalinity value in the ground water of study area varies from 250 to 440 mg/L during pre-monsoon season and 210 to 1020 mg/L during post-monsoon season. No sample exceeds the maximum permissible limit of 600 mg/L during pre-monsoon season while most of the samples exceeded the permissible limit during post-monsoon season.

Hardness of water is due to carbonates, sulphates and chlorides of calcium and magnesium. A limit of 300 mg/L as desirable limit and 600 mg/L as permissible limit has been recommended for drinking water (BIS, 1991). The total hardness values in the study area range from 167 to 2200 mg/L during pre-monsoon season and 50 to 1750 mg/L during post-monsoon season. The ground water samples of Dharamkanta area, Village Dakari, Babuganj, Elena Company area, Jalimkhera, Magarwara and Maswasi crosses the permissible limit of 600 mg/L.

In ground water of the study area, the values of calcium range from 19 to 540 mg/L during pre-monsoon season and 12 to 412 mg/L during post-monsoon season and the values of magnesium vary from 21 to 204 mg/L during pre-monsoon season and 4.9 to 185 mg/L during post-monsoon season. The desirable limit for calcium and magnesium for drinking water are 75 and 30 mg/L respectively (BIS, 1991). In ground water, the calcium content generally exceeds the magnesium content in accordance with their relative abundance in rocks. Further, ground water samples of Dharamkanta, Village Dakari, Magarwara and Maswasi exceeds the maximum

permissible limit of 200 mg/L for calcium and ground water samples of Village Dakari, Babuganj, Elena Company area, Jalimkhera and Maswasi exceeds the maximum permissible limit of 100 mg/L for magnesium**.**

The concentration of sodium in the study area varies from 72 to 522 mg/L during pre-monsoon season and 6.0 to 805 mg/L during post-monsoon season. The Bureau of Indian Standards has not included sodium in drinking water standards. The high sodium values in the study area may be attributed to base-exchange phenomena and causes sodium hazard. Ground water with such high sodium is not suitable for irrigation purpose.

Potassium is an essential element for humans, plants and animals and derived in food chain mainly from vegetation and soil. The main sources of potassium in ground water include rain water, weathering of potash silicate minerals, use of potash fertilizers and use of surface water for irrigation. The concentration of potassium in ground water of the study area varies from 4.5 to 19 mg/L during pre-monsoon season and 1.6 to 53 mg/L during post-monsoon season The Bureau of Indian Standards has not included potassium in drinking water standards. However, the European Economic Community has prescribed guideline level of potassium at 10 mg/L in drinking water. As per EEC criteria, ground water samples of Dharamkanta, Village Dakari, Babuganj, Jalimkhera, Gajauli, Bijalamau and Maswasi exceed the guideline level of 10 mg/L.

The concentration of chloride varies from 113 to 2076 mg/L during pre-monsoon season and 7.1 to 1420 mg/L during post-monsoon season. Three samples of the study area exceed the desirable limit of 250 mg/L during pre-monsoon season and nine samples during post-monsoon season. Ground water samples of Village Dakari and Maswasi exceeded the maximum permissible limit of 1000 mg/L. The limits of chloride have been laid down primarily from taste considerations. A limit of 250 mg/L chloride has been recommended as desirable limit and 1000 mg/L as the permissible limit for drinking water (BIS, 1991; WHO, 1996). However, no adverse health effects on humans have been reported from intake of waters containing even higher content of chloride.

The concentration of sulphate in the study area varies from 9.0 to 1724 mg/L during pre-monsoon season and 3.4 to 1080 mg/L during post-monsoon season. Bureau of Indian standard has prescribed 200 mg/L as the desirable limit and 400 mg/L as the permissible limit for sulphate in drinking water. In the study area, four the samples exceed the maximum permissible limit of 400 mg/L during pre-monsoon season and two samples during post-monsoon season. The sulphate content in ground water generally occurs as soluble salts of calcium, magnesium and sodium.

Nitrate content in drinking water is considered important for its adverse health effects and moderately toxicity. A limit of 45 mg/L has been prescribed by WHO (1996) and BIS (1991) for drinking water supplies. Its concentration above 45 mg/L may prove detriment to human health. In higher concentrations, nitrate may produce a disease known as methaemoglobinaemia (blue babies) which generally affects bottle-fed infants. Repeated heavy doses of nitrates on ingestion may also cause carcinogenic diseases. The nitrate content in the study area was not observed in any of the collected samples during pre-monsoon season but varies from 0 to 107 mg/L during

post-monsoon season with more than permissible limit of 45 mg/L in the ground water of Babuganj area, Elena Company area, CETP Banthar area, Shekhpur and Maswasi which may be attributed to contamination by industrial/domestic waste disposal.

The presence of fluoride in ground water may be attributed to the localized effects of natural sources. The fluoride is present in soil strata due to the presence of geological formations like fluorspar, fluorapatite, ampheboles such as hornblinde, trimolite and mica. Weathering of alkali, silicate, igneous and sedimentary rocks specially shales contribute a major portion of fluorides to ground waters. In addition to natural sources, considerable amount of fluorides may be contributed due to man's activities. Fluoride salts are commonly used in steel, aluminium, bricks and tile-industries. The fluoride containing insecticides and herbicides may be contributed through agricultural runoff. Phosphatic fertilizers, which are extensively used, often contain fluorides as impurity and these may increase levels of fluoride in soil. The accumulation of fluoride in soil eventually results in its leaching due to percolating water, thus increase fluoride concentration in ground water. The fluoride content in the ground water of the study area varies from 0.33 to 4.9 mg/L. Three samples (Maswasi, Lily Park, TW No. 4 and Deora Khurd) exceed the maximum permissible limit of 1.5 mg/L during post-monsoon season which may be attributed to localized geogenic/anthropogenic activities.

From the above discussion, it is quite clear that in the study area, the concentration of total dissolved solids was observed within the desirable limit of 500 mg/L in two of the samples and exceeded the maximum permissible limit of 2000 mg/L in four samples during pre-monsoon season. Most of the samples have TDS values above the desirable limit of 500 mg/L and five samples (G-5, G-6, G-26, G-44 and G-55) have TDS values even more than the maximum permissible values during post-monsoon season. The hardness values also observed to exceed the permissible limit in ground water samples of Dharamkanta area, Village Dakari, Babuganj, Elena Company area, Jalimkhera, Magarwara and Maswasi. The concentration of nitrate exceeded the permissible limit in Babuganj area, Elena Company area, CETP Banthar area, Shekhpur and Maswasi. The concentration of fluoride exceeded the permissible limit in the ground water of Maswasi, Lily Park, TW No. 4 and Deora Khurd. The violation of BIS limit could not be ascertained for sodium and potassium as no permissible limit for these constituents has been prescribed in BIS drinking water specifications.

7.2.2 Heavy Metals

Heavy metals in ground water have a considerable significance due to their toxicity and adsorption behaviour. Heavy metals are not biodegradable and enter the food chain through a number of pathways causing progressive toxicity due to the accumulation in human and animal organs during their life span on long term exposure to contaminated environments. Despite the presence of trace concentrations of Cr, Mn, Co, Cu and Zn in the aquatic environment, which is essential to a number of life processes, high concentrations of these metals become toxic. The major sources of heavy metals in ground water include weathering of rock minerals, discharge of sewage and other waste effluents on land and runoff water. The toxic effects of these elements and extent of their contamination in ground water is discussed in the following sections.

Iron (Fe): The concentration of iron in the ground water of the study area ranges from 0.54 to 17 mg/L during pre-monsoon season and 0.008 to 0.822 mg/L during post-monsoon season. The Bureau of Indian Standards has recommended 0.3 mg/L as the desirable limit and 1.0 mg/L as the maximum permissible limit for iron in drinking water (BIS, 1991). It is evident from the results that all samples of the study area exceed the desirable limit of 0.3 mg/L and four samples even exceed the maximum permissible limit of 1.0 mg/L during pre-monsoon season while all the samples were found within the maximum permissible limit during post-monsoon season. The maximum concentration of iron at Maswasi may be attributed to leaching of wastes from City Jail Drain during pre- and post-monsoon seasons.

It is a known fact that iron in trace amounts is essential for nutrition. High concentrations of iron generally cause inky flavour, bitter and astringent taste to water. Well water containing soluble iron remain clear while pumped out, but exposure to air causes precipitation of iron due to oxidation, with a consequence of rusty colour and turbidity. The objection to iron in the distribution system is not due to health reason but to staining of laundry and plumbing fixtures and appearance. Taste and order problems may be caused by filamentous organism that prey on iron compounds (frenothrix, gallionella and leptothrix are called iron bacteria), originating another consumer's objection (red water). The presence of iron bacteria may clog well screens or develop in the distribution system, particularly when sulphate compounds in addition to iron may be subjected to chemical reduction.

Manganese (Mn): The concentration of manganese ranges from 0.02 to 1.99 mg/L during pre-monsoon season and 0.012 to 0.400 mg/L during post-monsoon season.. Manganese is an essential trace nutrient for plants and animals, which does not occur naturally as a metal but is found in various salts and minerals frequently in association with iron compounds. Manganese may gain entry into the body by inhalation, consumption of food and through drinking water. A concentration of 0.1 mg/L has been recommended as a desirable limit and 0.3 mg/L as the permissible limit for drinking water (BIS, 1991). WHO has prescribed 0.5 mg/L as the provisional guideline value for drinking water (WHO, 1996). It is evident from the results that three samples of the study area fall within the desirable limit of 0.1 mg/L and four samples exceeds the maximum permissible limit of 0.3 mg/L during pre-monsoon season while twenty five samples fall within the desirable limit of 0.1 mg/L and only two samples exceeds the maximum permissible limit during post-monsoon season. The presence of manganese above permissible limit of drinking water often imparts alien taste to water. It also has adverse effects on domestic uses and water supply structures.

Copper (Cu): The concentration of copper ranges from 0.01 to 0.04 mg/L during pre-monsoon season and 0.004 to 0.187 mg/L during post-monsoon season. The Bureau of Indian Standards has recommended 0.05 mg/L as the desirable limit and 1.5 mg/L as the permissible limit in the absence of alternate source (BIS, 1991). Beyond 0.05 mg/L the water imparts astringent taste and cause discoloration and corrosion of pipes, fittings and utensils. World Health Organization has recommended 2.0 mg/L as the provisional guideline value for drinking purpose (WHO, 2011). In the study area, all of the samples fall below the desirable limit of 0.05 mg/L. In the study area, almost all of the samples fall below the desirable limit of 0.05 mg/L.

Nickel (Ni): The concentration of nickel ranges from ND to 0.29 mg/L during pre-monsoon season. World Health Organization has recommended 0.07 mg/L as the guideline value for drinking purposes (WHO, 2011). In this range it is not harmful in drinking water. In the study area, three samples exceed the WHO limit of 0.07 mg/L. The violation of BIS limit could not be ascertained as permissible limit of nickel has not been prescribed in BIS drinking water specifications.

Chromium [Cr(VI)]: The concentration of chromium (VI) ranges from 0.01 to 4.24 mg/L during pre-monsoon season and 0 to 0.922 mg/L during post-monsoon season. A concentration of 0.05 mg/L has been recommended as a desirable limit for drinking water (BIS, 1991). WHO has also prescribed 0.05 mg/L as the guideline value for drinking water (WHO, 2011). In the study area, the concentration of Cr (VI) in ground water samples of Dharamkanta area and village Dakari exceed permissible limit for drinking water during pre-monsoon season which may be attributed to dumping of chrome bearing solid waste. Chrome bearing solid waste was found illegally dumped along National Highway (Shyam Shanti Uchch Shiksha Sansthan Premises, Near JAAR Inter College and Slaughter House Dumping Site). The development around Janta Dharam Kanta along National Highway has come on the Basic Chrome Sulfate laden solid waste. Ground water sample collected from this site was completely yellow in colour indicating the presence of high Cr^{+6} contamination. During post-monsoon season, the concentration of Cr (VI) in ground water samples of Roadways Workshop and Elena Company area exceeded permissible limit for drinking water. Chromium contamination is a localized effect of dumped waste in Dahi Chowki / Dharamkanta area and its impact has been observed in shallow aquifers.

Hexavalent chromium has a deleterious effect on the liver, kidney, and respiratory organs with hemorrhagic effects, dermatitis, and ulceration of the skin for chronic and subchronic exposure. Municipal wastewater release considerable amount of chromium into the environment. In the natural environment, Cr(+6) is likely to be reduced to Cr(+3), thereby reducing the toxic impact of chromium discharges. The pathways of chromium contribution to ground water are that the chromium containing industrial effluent discharged into stream, the hexavalent state chromium may be reduced to trivalent state and later adsorbed on the suspended particlaute. In case, it could not be adsorbed, the chromium remain in the form of colloidal suspension, may precipitate and become part of stream sediment, from where it may reach to ground water through percolation containing shallow aquifers.

Lead (Pb): In the study area, the concentration of lead ranges from ND to 0.03 mg/L during pre-monsoon season and 0.005 to 0.102 mg/L during post-monsoon season. The Bureau of Indian Standards has prescribed 0.05 mg/L lead as the desirable limit for drinking water (BIS, 1991). Beyond this limit, the water becomes toxic. WHO has also prescribed 0.01 mg/L as guideline value for drinking water (WHO, 2011). In the study area, all the samples fall within the desirable limit for drinking water as prescribed by BIS (1991) during pre-monsoon season and sixteen samples exceeded the limit during post-monsoon season.

Lead is not considered an essential nutritional element and is a cumulative poison to humans. Acute lead poisoning is extremely rare. The typical symptoms of advanced lead poisoning are constipation, anemia, gastrointestinal disturbance, tenderness and gradual paralysis in muscles, specifically arms with possible cases of lethargy and moroseness. The major source

of lead contamination is the combustion of fossil fuel. Lead is removed from the atmosphere by rain and falls back on the earth surface and seeps into the ground. Lead passes from the soil to water and to the plants and finally into the food chain. In drinking water it occurs primarily due to corrosion of lead pipes and solders, especially in areas of soft water. It may be noted that the use of soft water of slightly acidic pH and the use of lead pipes in service and domestic water lines may provide higher concentrations of lead at the consumers's tap, particularly when the water use is minimal in the household (overnight still water in pipes).

Cadmium (Cd): The cadmium content is not detected in the collected samples of the study area. The Bureau of Indian Standards has prescribed 0.01 mg/L cadmium as the desirable limit for drinking water (BIS, 1991). Beyond this limit, the water becomes toxic. WHO has prescribed 0.003 mg/L cadmium as the guideline value for drinking water (WHO, 2011). The drinking water having more than 10 µg/L of cadmium can cause bronchitis, emphysema, anaemia and renal stone formation in animals.

Zinc (Zn): The concentration of zinc in the study area ranges from 0.05 to 1.44 mg/L during pre-monsoon season and 0.002 to 5.212 mg/L during post-monsoon season. The Bureau of Indian Standards has prescribed 5.0 mg/L zinc as the desirable limit and 15 mg/L as the permissible limit for drinking water (BIS, 1991). WHO has prescribed 3.0 mg/L as the guideline value for drinking water (WHO, 2011). In the study area, all the samples were found within the desirable limit prescribed by BIS (1991) and WHO (2011).

From the above results, it is quite clear that the presence of heavy metals has been recorded in many location and the water quality standards have been violated for iron (4 samples), manganese (4 samples), nickel (3 samples) and chromium (3 samples) out of 7 samples collected during pre-monsoon season and manganese (2 samples), chromium (2 samples) and lead (15 samples) out of 53 samples collected during post-monsoon season. The chemical analysis results of ground water samples of post-monsoon season shows that –

1. Electrical conductivity of 5 samples (Sample No. G-5, G-6, G-26, G-44, G-55) is more than 3000 µS/cm and one sample at Dakari (Sample No. G-5) has 7100 µS/ cm due to impact of boiler waste on ground water contamination.
2. Nitrate values in Sample No. G-9, G-10, G-26, G-39, G-44 has been found more than 45 mg/L, probably due to contamination by industrial / domestic waste disposal.
3. Fluoride values are more than 1.5 mg/L in Sample No. G-6, G-46, G-54 probably due to localized geogenic / anthropogenic activities.
4. Total hardness in Sample No. G-5, G-6, G-9, G-26, G-44, G-47, G-51, G-55) is more than 600 mg/L, the prescribed limit of BIS,
5. Hexavalent Cr in Sample No. G-12 and G-26 is remarkably high probably due to impact of dumped Cr waste in the ground.
6. Lead content at Sample No. G-5, G-6, G-7, G-8, G-10, G-18, G-20, G-22, G-23, G-26, G-30, G-44, G-48, G-51 and G-55 exceed the permissible limit of 50 µg/L. The high values of lead at these locations may be due to disposal of industrial waste in the surrounding area.
7. Chromium contamination in ground water is a localized effect of dumped waste in certain areas like Dahi Chowki and Dharam Kanta area and its impact has been observed in shallow aquifer.

7.2.3 Quality of Drinking Water Supply

The quality of water supply in industrial area through Tubewells (Babuganj TW No. 11, Pitambar Nagar TW No. 10, Kasif Ali Sarai TW No. 3, Lily Park Awas Vikas TW No. 4 and Payjal Yojna TW) was assessed for drinking purpose. The ground water of Babuganj Tubewell No. 11 violated the drinking water standards (BIS, 1991) for hardness, nitrate and magnesium. The ground water of Lily Park Awas Vikas Tubewell No. 4 violated the drinking water standard (BIS, 1991) for fluoride which may be attributed to localized geogenic/anthopogenic activities.

8. Concluding Remarks and Recommendations

1. The effluent discharged by both the Common Effluent Treatment Plants (Unnao CETP and Banthar CETP) do not conform to the effluent standards notified vide S.No. 55(B); G.S.R. 93(E) dated 21.2.1991 under Environment (Protection) Act, 1986 for discharge of effluent into inland surface water in respect of TDS, TSS, total chromium, BOD and COD and needs appropriate statutory action by UPPCB/CPCB. The analysis results of pre- and post-monsoon season also indicate that the values are not in conformity with the effluent standards in both the seasons.
2. The effluent discharged by various industries (M/s Mirja International Limited, M/s Mustang Leather Pvt. Ltd., M/s Sadaf Enterprises Pvt. Ltd., M/s Rehman Industries, M/s Indagro Foods Ltd. and M/s AOB Exports Pvt. Ltd., M/s Omega International, M/s Allied Leather Finishers Pvt. Ltd., M/s Rustam Food Pvt. Ltd., M/s Falak Enterprises and M/s Asharfi Agro Byproducts, M/s Resinova Chemicals, M/s Handloom Bhandar, M/s Rimjhim Stainless Ltd., M/s Bajaj Kagaj Udyog Ltd., M/s J. S. International, M/s Mahavir Spin Fabrics, M/s Balaji Industries Ltd., M/s ACI Oils Pvt. Ltd., M/s Jeet Dyeing Industries, M/s Sadaf Dyeing and Proofing, M/s Universal Yarn and Textile Pvt. Ltd.) with their own full-fledged Effluent Treatment Plants (ETPs) do not conform to the effluent standards notified under Environment (Protection) Act, 1986 for discharge of effluent into inland surface water and needs appropriate statutory action by UPPCB/CPCB.
3. All the areas monitored have insufficient provision for proper collection and disposal of sewage as well as industrial effluents and have high potential of ground water contamination. The injudicious disposal of solid waste has further compounded the problem and need priority attention in a time bound manner.
4. Chrome bearing solid waste was found illegally dumped along National Highway (Shyam Shanti Uchh Shiksha Sansthan Premises, Near JAAR Inter College and Slaughter House Dumping Site). The development around Janta Dharam Kanta along National Highway has come on the Basic Chrome Sulfate (BCS) laden solid waste. The practice of indiscriminate dumping of chromium laden solid waste needs to be immediately stopped. Priority actions should be taken in areas where high concentration of chromium in soils/ground water is found to avoid any further contamination.
5. Numerous bio-fertilizer industries are mushrooming throughout the industrial area especially in Dakari Village. Processed wastes from tanneries are being used as raw materials by these industries. These units have potential hazards for air, soil and water environment and therefore appropriate action is required to be taken up by the concerned authorities.
6. The Loni Drain and City Jail Drain carries sewage as well as industrial effluent to River Ganga through unlined channels (open drains). City Jail Drain stagnates at several places (e.g. Gehra close to Lucknow-Kanpur highway) and causes serious impact on ground water, soil and nearby vegetation. The untreated sewage and industrial effluents flowing in open drains are one of the major causes of ground water quality deterioration. Proper underground sewerage system must be laid in all inhabited areas and the untreated sewage and industrial wastes should not be allowed to flow in open drains.

7. A proper system of collection and transportation of domestic waste should be developed. Land fill site(s) should be identified and it must be scientifically designed for disposal of domestic waste. Ground water quality near land fill sites should be regularly monitored.
8. The quality of ground water has deteriorated due to indiscriminate dumping of solid wastes along National Highway in the vicinity of Dharam Kanta and discharge of sewage and industrial effluents beyond the prescribed limits in open drains (Loni Drain and City Jail Drain).
9. Chromium contamination in ground water is a localized effect of dumped waste in certain areas like Dahi Chowki and Dharam Kanta areas and its impact has been observed in shallow aquifer.

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Annex – I

Letter from Smt. Annu Tandon, Hon'ble Member of Parliament (Lok Sabha)

ANNU TANDON
Member of Parliament
(Lok Sabha)

सत्यमेव जयते

Permanent Address:
66, Mubariz Nagar,
Narain Bhawan, Dhawan Road,
Unnao (U.P.) - 209801
Delhi Address:
41, Meena Bagh,
New Delhi - 110003

Copy

Dated: 01st March 2012

To,
Shri Pawan Kumar Bansal,
Hon'ble Union Minister,
Ministry of Water Resources,
Shram Shakti Bhawan, Rafi Marg, N.D. - 01

Respected Sir,

Subject: Seeking your kind intervention on the pollution caused by Leather Tanning Industry to the water-bodies / groundwater in Unnao district of Uttar Pradesh.

I am writing to draw your kind attention towards the rampant pollution caused to the water-bodies / groundwater by the leather tanning industry in Unnao district of Uttar Pradesh. I have been fighting for clean drinking water and clean ground water in Unnao and against the pollution caused especially by the Tanning Units & Slaughter Houses situated here, for many years now.

I have strongly taken up this issue with the Honourable Prime Minister, Honourable UPA Chairperson, Honourable Commerce & Industry Minister, Honourable Environment & Forest Minister, Central Pollution Control Board (CPCB) & with the Central Ground Water Board (CGWB) falling under your esteemed Ministry, on several occasions. I am happy to have received their support and assurances for saving the people from any further environmental damage.

In this regard, I have met Shri. Anand Sharma, Honourable Commerce & Industry Minister (Govt. of India) and he was kind enough to have convened a joint meeting of top bureaucrats from his ministry and the Ministry for Environment and Forest and the issue was discussed in detail.

Phones: Office (Delhi): +91-11-23792421 Mob.: +91-9013180225 Fax: +91-11-23792422
Office (Unnao): Mob.: +91-9532299020 Fax: +91-515-2820263
Helpline No.: +91-515-2822999 Mob.: +91-9236635973

The Honourable Commerce & Industry Minister also called another meeting of all the stakeholders to discuss the issue of pollution due to Leather Tanneries & Slaughter Houses and it was agreed that alternative solutions be considered to reduce the usage of salt rather salt-less preservation methodology be identified.

Earlier, Shri Jairam Ramesh, erstwhile Honourable Environment & Forest Minister visited Kanpur to launch the Green Technology - "Salt-less preservation of Hides/Skins through Lyophilisation Process", and inaugurated the Lyophilizor Machine, for demonstration purposes at CETP, Jajmau, Kanpur (Uttar Pradesh). The Honourable Minister also visited a Slaughter House belonging to Banthar Leather Park in Unnao and instructed Chairman, Central Pollution Control Board to install a Lyophilizor Unit in one Slaughter House so that its viability could be checked by the industrialists themselves, at the ground level.

In the last couple of years I have also been able to convince two independent agencies – Indian Institute of Toxicology Research (IITR), Lucknow, and the Central Ground Water Board (CGWB) to send a team of scientists to Unnao to check for pollution in water-bodies / groundwater sources and the presence of harmful heavy metals in the treated and untreated effluents being released by the leather tanneries.

I am giving you a brief summary of the main findings of the reports for your consideration:

1. 18 water samples collected by the IITR team and 13 were found to exceed the BIS recommendations for Total Dissolved Solids (TDS) and Fluoride levels.
2. Mercury was found in one sample, while out of the four samples collected from the Dahi Chowki Common Effluent Treatment Plant (CETP) and the Banthar Leather Park CETP, two samples were found to have concentrations of chromium much higher than the prescribed levels.

MEMBER OF PARLIAMENT
(LOK SABHA)

सत्यमेव जयते

3. In all four samples collected from the CETPs the Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) was higher than the recommended limit.
4. The CGWB team collected water samples from 45 locations. In groundwater samples maximum concentration of copper, cadmium, chromium, zinc, lead, iron, manganese and nickel was found.
5. The presence of heavy metals copper, cadmium, chromium, lead, iron and manganese from so-called treated water coming from leather tanning industries and slaughter units which had installed individual Effluent Treatment Plants (ETPs) into the CEPT was also above the BIS prescribed limits
6. There was presence of chromium, above the BIS prescribed limits, in the outflow from both the CETPs in Dahi Chowki and Banthar Leather Park.

I am enclosing copies of both the reports for your kind consideration. The same has already been submitted to all concerned Central / State Ministries & departments. The said reports clearly substantiate that ongoing contamination of the water-bodies / groundwater is taking place in Unnao district.

Sir, I want to request you to appoint a special team of investigators from your esteemed Ministry to find out facts about the present state of Unnao's water-bodies / groundwater, how much of Unnao's groundwater is affected so far, which particular tanning units are responsible for causing pollution to our water-bodies so that timely notices could be served to all offenders and the blatant violations of norms by the powerful leather tanning mafia are put to an end once and for all. I am requesting for your personal intervention to save the future of over 30 lakh people of Unnao.

Thanking you in anticipation.

Warm regards,

Anu Tandon

Annex – II

Constitution of Committee Constituted by Ministry of Water Resources, Govt. of India

File.No.8/6/2011-WQ/4203-05
Government of India
Ministry of Water Resources
(Water Quality Division)
***

1103, Ansal Bhawan
Kasturba Gandhi Marg,
New Delhi – 110 001
Dated: March 13, 2012

Subject: Pollution Caused by Leather Tanning Industry to the water bodies/ground water in Unnao district of Uttar Pradesh.

Please find enclosed herewith a letter received from Smt. Anu Tandon, Hon'ble M.P. (Lok Sabha) regarding rampant pollution of water bodies and ground water by industrial units especially leather tannery industry in Unnao district, U.P. Hon'ble M.P. has forwarded a report consisting of findings from two independent agencies-Indian Institute of Toxicology Research (IITR) Lucknow and thc Central Ground Water Board (CGWB) Northern Region Lucknow and photographs of polluted drains and industrial dumps along the National Highway and within the industrial area, which are enclosed (Annexure-I). Central Ground Water Board has also submitted an Executive Summary of Water Quality Reports of Unnao district which is also enclosed (Annexure-II). CGWB has recommended that that appropriate statutory action in this matter is required from CPCB/SPCB for mitigation of industrial pollution.

In view of the above, it has been decided that a committee be constituted to investigate the present extent to which Unnao's water bodies/ ground water has been affected and the industrial units responsible for causing pollution to the water bodies in the region. The composition of the committee is as follows:

1. Director (NIH) - Chairman
2. Director (RDD), CWC - Member
3. Regional Director, CGWB (NR)- Member

The committee may co-opt a member from CPCB and UPSCB.

The committee must complete its findings and submit report with recommendation within two months. The Terms of Reference (ToR) for the committee are also enclosed.

Encl: As above.

(Rajeev Kumar)
Director(GW)

To:

1. Director (NIH), Jalvigyan Bhawan, Roorkee – 247 667
2. Director (RDD), CWC, West Block-1, Wing-4, IInd Floor, R.K. Puram, New Delhi – 110 022.
3. Regional Director, CGWB, Northern Region, Bhujal Bhawan, Sector-B, Sitapur Road Yojana, Lucknow – 226 021.

Annex – III

Heavy Metals in Ground Water and Effluent Samples of Unnao

S.No.	Location	Source	Cu	Cr	Mn	Zn	Ni	Pb	Fe	Cd
	Permissible limit (mg/L)	**-**	**1.5**	**0.05**	**0.3**	**15.0**	**-**	**0.05**	**1.0**	**0.01**
1.	Jalimkhera (Ram Kumar)	IM-II	0.03	0.010	0.635	0.903	0.009	ND	4.387	0.001
2.	JalimKhera (Ram Kumar)	DW	0.002	0.005	1.280	0.203	0.008	0.003	0.803	0.001
3.	Gay Prasad Laukhera	IM-II	0.002	0.006	0.453	1.374	0.007	0.008	1.021	0.001
4.	Gay Prasad Laukhera	DW	ND	0.007	0.728	0.202	0.003	0.001	1.111	0.002
5.	Bauther ETP (After)	Eff.	ND	3.254	0.116	1.657	0.043	0.015	0.359	0.001
6.	Bauther ETP (before)	Eff.	0.006	14.762	0.278	1.350	0.011	0.006	2.487	0.001
7.	Sarab Mill	Eff.	0.004	0.002	0.054	0.100	0.007	ND	0.246	0.001
8.	Adargh Nagar	IM-II	ND	0.005	2.426	0.173	0.007	0.007	1.256	0.012
9.	Kasim Abbas Zaidi	IM-II	ND	0.004	0.070	0.138	0.008	0.021	2.054	0.002
10.	Sunil, Sekhpur Nari	IM-II	0.003	0.004	0.058	0.545	0.004	0.006	0.258	0.001
11.	Sukhram, Baghoura	IM-II	0.002	0.003	0.326	0.107	0.006	0.009	0.498	0.001
12.	Sariya Ayurved Hospital	IM-II	0.002	0.004	0.266	0.810	0.005	0.004	1.028	0.001
13.	Dahi Chowki CETP (After)	Eff.	0.002	0.488	0.054	0.910	0.002	0.017	0.199	0.001
14.	Dahi Chowki CETP (Before)	Eff.	0.006	0.517	0.180	0.920	0.009	0.041	0.747	0.001
15.	Vinod Jhayhari	Pvt. HP	0.005	0.005	0.099	0.289	0.008	0.004	0.105	0.001
16.	Temple Shaukarj Jhauyhari	DW	0.009	0.004	0.125	0.850	0.011	0.001	0.148	0.001
17.	Devi Charan, Garhi	IM-II	0.010	0.009	0.264	0.686	0.009	ND	2.919	0.001
18.	Ashok Kumar Goshi	IM-II	ND	0.004	0.128	0.264	0.008	0.005	0.463	0.002
19.	Central School, Water Tank	IM-II	0.002	0.004	0.130	0.389	0.011	0.022	0.418	0.001
20.	Servant Quater Nawanganj Pachhi Vihar	IM-II	ND	0.003	0.398	0.501	0.001	0.001	0.326	0.001
21..	Yogandra, Vaktu Khera	IM-II	ND	ND	0.177	0.519	0.007	ND	0.329	0.001
22.	Kamal Srivastav, Sudha House	Port HP	ND	ND	0.324	0.367	0.007	ND	2.052	0.001
23.	Alok Gupta, Avas Bikas Col.	IM-II	0.003	0.003	0.121	0.201	0.001	ND	0.233	0.001
24.	Lili Park Awas Bikas Colny.	DTW	ND	ND	0.076	0.408	0.009	ND	0.106	0.001
25..	Girija Shankar Pandey, Civilins Ummari	IM-II	ND	0.008	0.091	0.303	0.009	ND	0.422	0.001

Annex – IV

Arsenic Content in Ground Water of Unnao District, Uttar Pradesh

S.No.	Location	Type	Date of Collection	As (µg/L)
1.	Effluent CEPT, Banthar, mixed	Effluent	12.12.11	12.2
2.	Effluent CEPT, Banthar, left	Effluent	12.12.11	11.4
3.	Effluent CEPT, Banthar, right	Effluent	12.12.11	12.2
4.	Submissble Pump near CEPT	SP	12.12.11	12.2
5.	J S Slaughter House	Effluent	12.12.11	11.0
6.	Benthar	IM II	12.12.11	13.0
7.	Lauikhera	DW	12.12.11	28.2
8.	Gaya prasad, Laukhera	IM II	12.12.11	11.0
9.	Sambhu, Laukhera	IM II	12.12.11	7.7
10.	Manglal, Laukhera	IM II	12.12.11	12.2
11.	Sushil, Laukhera	Pvt. HP	12.12.11	13.4
12.	Jagannath Jalimkhera	DW	12.12.11	25.7
13.	Ramkumar Jalimkhera	Pvt. HP	12.12.11	21.2
14.	JagawathJalimkhera	Pvt. HP	12.12.11	21.6
15.	Raj bhadur, Dakari	Pvt. HP	12.12.11	118.3
16.	Mahesh Singh, Dakari	Pvt. HP	12.12.11	71.3
17.	Khadi bhawan, Shuklaganj	Pvt. HP	12.12.11	637.7
18.	Ayurwedik hospital, maswari	IM II	12.12.11	68.7
19.	Maduwasi	IM II	12.12.11	11.0
20.	Drain in side, Maduwasi	Drain	12.12.11	12.6
21.	Sankar singh,Maduwasi	IM II	12.12.11	13.8
22.	Horilal,Maduwasi	IM II	12.12.11	13.0
23.	Kanya vidyalay,Maduwasi	IM II	12.12.11	10.2
24.	Mirza tannery drain, Unnao	Drain	12.12.11	16.3
26.	Makanpur Ghat, Temple	IM II	14.12.11	80.1
27.	Makanpur Ghat, Ganga	River	14.12.11	14.7
28.	Makanpur Ghat, Ganga	River	14.12.11	12.2
29.	Gangasagar, Katari in field	TW	14.12.11	103.0
30.	PWD Ganghut	IM II	14.12.11	45.4
31.	Melalam sah	DW	14.12.11	12.2
32.	Pond on road	SW	14.12.11	16.3
33.	Prim School, Munnipurwa	IM II	14.12.11	8.1
34.	Indra Pal, Munnipurwa	Pvt. HP	14.12.11	16.7
35.	Rupan, Bhudda	Pvt. HP	14.12.11	97.3
36.	Nanhu, Bhudda	IM II	14.12.11	39.6
37.	Nanhu, Bhudda	Pvt. HP	14.12.11	11.0
38.	Subedar, Antwa	Pvt. HP	14.12.11	13.8
39.	Jagdish, Antwa	IM II	14.12.11	6.1
40.	Prim School, Antwa	IM II	14.12.11	126.8
41.	Antwa Xing	Pvt. HP	14.12.11	20.0
42.	Dalla, Bhudda	Pvt. HP	14.12.11	41.7
43.	Asha Singh, Bhudda	Pvt. HP	14.12.11	79.2
44.	Jairam, Naubatganj	IM II	14.12.11	6.9
45.	Jairam, Naubatganj	Pvt. HP	14.12.11	3.6
46.	Jairam, Naubatganj	DW	14.12.11	22.4
47.	PHC, Naubatganj	IM II	14.12.11	3.6
48.	Munna Awasthi, Rishinagar	Pvt. HP	28.12.11	17.0
49.	New Krishna sweet	IM II	28.12.11	89.0
50.	D C Dwedi, Risinagar	Pvt. HP	28.12.11	56.0
51.	J L Dwedi, Risinagar	Pvt. HP	28.12.11	85.0
52.	Pal Traders,Subasnagar	Pvt. HP	28.12.11	45.0
53.	Hanu.Temple, Ambikapuram	IM II	28.12.11	13.0
54.	Vinod Rathor,Suklaganj	Pvt. HP	28.12.11	21.0
55.	JHS Singrausi, Dharmkanta	IM II	28.12.11	13.0

56.	JAR Intercollege,Dharamkanta	SW	28.12.11	7.0
57.	JAR Intercollege,Dharamkanta	TW	28.12.11	3.0
58.	Pintu Gupta, Sivnagar	Pvt. HP	28.12.11	8.0
59.	Eff CEPT, Dahi Chowki	Effluent	28.12.11	6.0
60.	Eff CEPT, Dahi Chowki	Effluent	28.12.11	33.0
61.	CEPT, Dahi Chowki	IM II	28.12.11	12.0
62.	Garhi, Nr tower	Pvt. HP	28.12.11	0.1
63.	Jhanjhari	DW	28.12.11	6.0
64.	Central School	IM II	28.12.11	13.0
65.	Masnagar	IM II	28.12.11	26.0
66.	Masnagar invillage	DW	28.12.11	32.0
67.	Masnagar onroad	DW	28.12.11	14.0
68.	CEPT	Effluent	28.12.11	ND
69.	J S Slaughter House	Effluent	28.12.11	ND

SP - Submersible Pump, IM II - India Mark, DW - Dug Well, HP – Hand Pump; SW - Surface Water, ND - Not Detected

Annex - V

Ground Water Quality in Unnao District, Uttar Pradesh

S.No.	Location	Type	pH	EC (µS/cm)	Cr(VI) µg/L	Total Cr (µg/L)	F (mg/L)
1.	Left Effluent Benther	Effluent	7.67	1310	ND	1	1.25
2.	Right Effluent Benther	Effluent	7.78	4000	ND	6	2.11
3.	Mixed Effluent CEPT Benther	Effluent	7.61	1860	ND	-	1.29
4.	TW near CEPT	SP	7.52	668	ND	-	1.48
5.	J S Slaughter House	Effluent	7.62	698	ND	11	1.17
6.	Benthar	IM II	7.22	746	ND	6	0.96
7.	Lauikhera	DW	8.01	5860	ND	45	0.98
8.	Gaya prasad, Laukhera	IM II	7.25	4170	ND	31	0.76
9.	Sambhu, Laukhera	IM II	7.42	781	ND	0	0.98
10.	Manglal, Laukhera	IM II	7.28	982	1.39	2	0.79
11.	Sushil, Laukhera	HP	7.26	763	ND	11	3.21
12.	Jagannath Jalimkhera	DW	7.38	2030	ND	26	1.18
13.	Ramkumar Jalimkhera	HP	7.21	1630	ND	26	0.99
14.	Jagawath Jalimkhera	HP	7.17	1490	ND	26	1.07
15.	Raj Bhadur, Dakari	HP	6.98	6120	ND	50	0.91
16.	Mahesh Singh, Dakari	HP	7.02	3330	ND	-	0.4
17.	Khadi bhawan, Shuklaganj	HP	7.44	1880	ND	-	1.52
18.	Ayurwedik hospital, Maswari	IM II	7.06	2050	ND	-	0.49
19.	Maduwasi	IM II	7.46	4310	ND	-	0.88
20.	Drain in side, Maduwasi	Drain	7.72	1710	ND	-	3.31
21.	Sankar Singh, Maduwasi	IM II	6.94	3040	0.21	-	1.75
22.	Horilal, Maduwasi	IM II	7.34	1860	ND	102	0.72
23.	Kanya Vidyalay, Maduwasi	IM II	7.18	4600	ND	-	1.05
24.	Mirza tannery drain, Unnao	Drain	7.58	1330	ND	4455	2.75
25.	Unnao distillery	Drain	7.98	795	ND	31	0.72
26.	Makanpur ghat, Temple	IM II	6.98	312	-	-	0.37
27.	Makanpur ghat, Ganga	River	7.31	341	-	-	0.22
28.	Makanpur ghat, Ganga	River	7.89	279	-	-	0.4
29.	Gangasagar, Katari in field	TW	7.01	431	-	-	0.22
30.	PWD Ganghut	IM II	7.03	405	-	-	0
31.	Melalam sah	DW	7.28	342	-	-	0.35
32.	Pond on road	SW	7.23	285	-	-	0.18
33.	Prim School, Munnipurwa	IM II	7.18	1020	-	-	1.72
34.	Indra Pal, Munnipurwa	HP	6.99	708	-	-	0.12
35.	Rupan, Bhudda	HP	6.75	549	-	-	0.22
36.	Nanhu, Bhudda	IM II	6.94	590	-	-	0.06
37.	Nanhu, Bhudda	HP	6.73	1240	-	-	0.45
38.	Subedar, Antwa	HP	7.01	711	-	-	0.08
39.	Jagdish, Antwa	IM II	7.08	467	-	-	0.75
40.	Prim School, Antwa	IM II	7.01	532	-	-	0.28
41.	Antwa Xing	HP	6.96	542	-	-	0.25
42.	Dalla, Bhudda	HP	7.01	553	-	-	0.41
43.	Asha Singh, Bhudda	HP	6.98	524	-	-	0.35
44.	Jairam, Naubatganj	IM II	6.81	1520	-	-	0.06
45.	Jairam, Naubatganj	HP	6.93	2000	-	-	0.18
46.	Jairam, Naubatganj	DW	7.38	1830	-	-	0.12
47.	PHC, Naubatganj	IM II	7.08	1500	-	-	0.03
48.	Munna Awasthi, Rishinagar	HP	7.08	1664	ND	16	0.45

49.	New Krishna sweet	IM II	7.42	902	ND	35	0.26
50.	D C Dwedi, Risinagar	HP	7.85	1204	ND	6	1.13
51.	J L Dwedi, Risinagar	HP	7.65	1440	ND	20	1.24
52.	Pal Traders,Subasnagar	HP	7.64	1227	ND	16	0.56
53.	Hanuman Temple Ambikapuram	IM II	7.72	643	ND	16	0.35
54.	Vinod Rathor,Suklaganj	HP	7.48	1664	ND	16	0.59
55.	JHS Singrausi, Darmkanta	IM II	7.70	888	ND	11	1.82
56.	JAR Inter college, Daramkanta	SW	7.76	3516	2070	4012	0.37
57.	JAR Inter college,Daramkanta	TW	7.76	2985	352	602	1.08
58.	Pintu Gupta, Shivnagar	HP	7.90	3552	ND	141	7.32
59.	CEPT, Dahi Chowki	Effluent	7.29	7398	ND	3984	0.94
60.	CEPT, Dahi Chowki	Effluent	7.26	19706	ND	3310	0.01
61.	CEPT, Dahi Chowki	IM II	7.60	1758	ND	21	1.01
62.	Garhi, Nr tower	HP	7.52	1068	ND	16	0.77
63.	Jhanjhari	DW	7.71	2726	ND	21	0.89
64.	Central School	IM II	7.74	674	ND	45	0.44
65.	Masnagar	IM II	7.49	1262	ND	54	0.44
66.	Masnagar in village	DW	7.26	2738	ND	21	1.08
67.	Masnagar on road	DW	7.06	952	ND	11	0.74
68.	CEPT	Effluent	7.08	23482	ND	-	0.01
69.	J S Slaughter House	Effluent	7.87	1782	ND	-	1.21

SP - Submersible Pump, IM II - India Mark, DW - Dug Well, HP – Hand Pump; SW - Surface Water, ND - Not Detected

Annex - VI

Water Quality Data of River Ganga at Kanpur for the period June 2001- May 2011#

 # WQ Stations Established by Central Water Commission on River Ganga at Upstream of Unnao, UP.

S.No.	Date	Temp (^{0}C)	Colour	Odour	EC (µmho/cm)	pH	NO3-N (mg/L)	NO2-N (mg/L)	BOD3-27 (mg/L)	CO3 (mg/L)	Na (mg/L)	Ca (mg/L)	Cl (mg/L)	SO4 (mg/L)	Mg (mg/L)	K (mg/L)	HCO3(mg/L)	F (mg/L)	Fe (mg/L)
1	Jun/01	30.0	Clear	Odour free	530	8.1		0.04	2.9	0.0	8.5	40	25.9	15.4	17.5	6.3	268	0.46	0.0
2	Jul/01	30.5	Clear	Odour free	260	8.1		0.01	3.2	0.0	6.2	34	24.1	9.1	15.4	5.1	142	0.21	0.0
3	Aug/01	31.0	Clear	Odour free	200	8.2		0.00	2.4	0.0	5.8	33	19.9	7.7	12.4	5.1	112	0.10	0.0
4	Sep/01	31.0	Clear	Odour free	240	8.1		0.00	2.7	0.0	6.2	36	22.0	11.5	15.4	5.5	132	0.00	0.0
5	Oct/01	31.5	Clear	Odour free	360	8.0		0.00	2.6	0.0	7.1	40	25.9	14.4	17.5	5.9	185	0.00	0.0
6	Nov/01	27.0	Clear	Odour free	500	8.0		0.00	2.2	0.0	7.6	41	28.1	11.0	18.6	6.3	254	0.06	0.0
7	Dec/01	21.0	Clear	Odour free	470	8.1		0.00	2.4	0.0	7.1	40	25.9	10.1	17.5	5.9	244	0.00	0.0
8	Jan/02	14.5	Brown	Odour free	370	8.1		0.00	2.2	0.0	6.2	38	24.1	10.1	16.5	5.5	195	0.00	0.0
9	Feb/02	16.5	Brown	Odour free	430	8.1		0.00	2.2	0.0	7.1	40	25.9	12.0	18.6	5.9	225	0.00	0.0
10	Mar/02	23.5	Brown	Odour free	450	8.2		0.00	2.9	0.0	7.4	41	28.1	13.9	19.6	6.3	206	0.10	0.0
11	Apr/02	26.5	Brown	Odour free	500	8.1		0.00	2.4	0.0	8.3	43	30.2	14.4	41.2	6.7	254	0.30	0.1
12	May/02	28.0	Clear	Odour free	600	7.9		0.01	2.9	0.0	9.0	45	34.1	16.3	21.6	7.0	307	0.53	0.2
13	Jun/02	30.5	Brown	Odour free	280	8.2		0.01	3.2	0.0	7.8	38	25.9	12.5	18.6	3.9	151	0.25	0.0
14	Jul/02	34.5	Brown	Odour free	330	8.0		0.00	2.4	0.0	8.5	34	25.9	11.5	14.5	7.0	171	0.00	0.0
15	Aug/02	31.5	Clear	Odour free	240	8.1		0.00	2.2	0.0	7.4	33	22.0	7.7	14.5	6.7	132	0.30	0.0
16	Sep/02	31.5	Clear	Odour free	220	8.0		0.00	2.9	0.0	6.9	34	19.9	5.8	15.4	6.3	117	0.00	0.0
17	Oct/02	31.0	Clear	Odour free	250	8.1		0.00	2.0	0.0	7.8	36	22.0	6.2	17.5	6.7	137	0.00	0.0
18	Nov/02	27.0	Clear	Odour free	360	7.4		0.00	2.3	0.0	8.7	38	24.1	9.1	18.6	7.4	185	0.00	0.0
19	Dec/02	20.5	Clear	Odour free	400	7.9		0.00	2.6	0.0	12.4	40	24.1	9.1	20.7	9.0	205	0.00	0.0
20	Jan/03	16.5	Clear	Odour free	350	7.7		0.00	2.4	0.0	12.2	40	25.9	12.0	20.7	8.6	234	0.29	0.0
21	Feb/03	15.5	Brown	Odour free	440	8.1		0.00	2.4	0.0	14.5	40	25.9	12.0	20.7	12.9	234	0.29	0.0
22	Mar/03	23.0	Brown	Odour free	340	8.1		0.00	2.7	0.0	12.0	38	24.1	10.1	18.6	6.7	181	0.00	0.0

23	Apr/03	27.0	Clear	Odour free	530	8.0		0.00	3.0	0.0	17.9	40	30.2	13.4	25.8	6.7	273	0.44	0.0
24	May/03	30.5	Brown	Odour free	550	7.9		0.00	3.0	0.0	17.9	41	32.0	15.4	33.9	6.7	274	0.59	0.0
25	Jun/03	31.5	Brown	Odour free	520	8.2		0.01	3.3	0.0	16.1	40	30.2	14.9	17.5	6.7	254	0.53	0.2
26	Jul/03	32.5	Clear	Odour free	280	8.0		0.00	2.7	0.0	9.9	34	24.1	10.1	17.5	6.3	161	0.25	0.0
27	Aug/03	30.5	Brown	Odour free	270	8.0		0.00	1.8	0.0	9.7	33	19.9	11.0	16.5	5.9	132	0.00	0.0
28	Sep/03	32.5	Brown	Odour free	200	7.9		0.00	2.4	0.0	9.7	31	16.0	10.1	14.5	6.3	146	0.00	0.0
29	Oct/03	30.0	Brown	Odour free	240	8.0		0.00	2.7	0.0	8.5	34	22.0	13.0	15.4	6.3	146	0.00	0.1
30	Nov/03	28.0	Brown	Odour free	410	7.9		0.01	3.0	0.0	13.8	38	25.9	14.4	17.5	6.7	156	0.00	0.1
31	Dec/03	22.0	Brown	Odour free	460	7.9		0.01	2.4	0.0	16.8	40	30.2	14.9	18.6	7.4	161	0.00	0.1
32	Jan/04	16.0	Brown	Odour free	410	7.8		0.01	2.2	0.0	16.1	34	25.9	12.5	16.5	6.7	293	0.15	0.1
33	Feb/04	16.5	Brown	Odour free	420	8.1		0.01	2.5	0.0	16.3	36	28.1	12.0	17.5	7.0	298	0.36	0.2
34	Mar/04	23.0	Brown	Odour free	500	7.9		0.01	2.9	0.0	18.2	41	32.0	13.4	19.6	7.8	264	0.65	0.3
35	Apr/04	28.5	Brown	Odour free	580	7.8		0.01	2.9	0.0	20.0	45	36.2	13.4	21.6	8.6	307	0.63	0.1
36	May/04	29.0	Brown	Odour free	600	8.0		0.01	2.6	0.0	22.1	42	38.0	18.7	24.8	9.0	323	0.63	0.2
37	Jun/04	33.0	Brown	Odour free	630	8.0		0.03	2.9	0.0	22.5	50	40.1	16.3	25.8	9.4	327	0.78	0.4
38	Jul/04	33.0	Brown	Odour free	370	7.9		0.01	2.9	0.0	11.0	38	30.2	13.9	19.6	6.7	156	0.65	0.2
39	Aug/04	31.5	Brown	Odour free	320	7.9		0.00	3.1	0.0	9.2	34	28.1	12.0	17.5	5.5	146	0.25	0.1
40	Sep/04	31.0	Clear	Odour free	280	8.0		0.01	2.7	0.0	8.7	33	24.1	15.8	16.5	5.5	137	0.46	0.0
41	Oct/04	31.5	Brown	Odour free	300	7.9		0.01	2.0	0.0	9.2	34	25.9	19.7	18.6	6.3	151	0.40	0.0
42	Nov/04	25.5	Brown	Odour free	440	7.9		0.01	3.1	0.0	10.8	40	28.1	23.5	21.6	6.7	249	0.59	0.0
43	Dec/04	22.5	Brown	Odour free	440	8.0		0.01	3.1	0.0	10.6	38	25.9	25.9	20.7	6.3	234	0.55	0.0
44	Jan/05	17.0	Brown	Odour free	470	8.1		0.01	2.8	0.0	11.0	40	28.1	27.8	21.6	7.0	229	0.38	0.0
45	Feb/05	19.0	Brown	Odour free	470	8.1		0.03		0.0	11.0	41	30.2	28.8	22.7	7.0	234	0.36	0.0
46	Mar/05	25.0	Brown	Odour free	630	7.7		0.03	4.3	0.0	15.0	46	34.1	35.5	25.8	8.6	264	0.13	0.2
47	Apr/05	28.5	Clear	Odour free	650	8.1		0.03	5.1	0.0	16.1	48	30.2	31.2	25.8	9.0	273	0.25	0.3
48	May/05	30.0	Brown	Odour free	570	8.1		0.03		0.0	18.2	45	25.9	22.1	24.8	8.2	244	0.21	0.0
49	Jun/05	34.0	Brown	Odour free	620	8.0		0.03	5.5	0.0	24.6	48	24.1	24.0	26.9	11.0	259	0.44	0.2
50	Jul/05	31.5	Brown	Odour free	530	8.0		0.01	5.1	0.0	23.0	43	19.9	19.2	23.7	10.6	239	0.61	0.2
51	Aug/05	32.5	Brown	Odour free	250	8.0		0.01	3.5	0.0	15.0	31	12.1	13.9	13.4	4.7	137	0.00	0.0
52	Sep/05	32.5	Brown	Odour free	320	8.1		0.01	3.1	0.0	15.2	36	18.1	15.8	16.5	5.1	146	0.00	0.0
53	Oct/05	31.5	Brown	Odour free	320	7.9		0.01	2.6	0.0	15.0	34	16.0	15.4	15.4	4.7	142	0.00	0.0
54	Nov/05	26.5	Brown	Odour free	380	7.8		0.01	3.3	0.0	15.4	36	18.1	17.8	16.5	6.3	146	0.00	0.0

55	Dec/05	21.5	Brown	Odour free	390	8.1		0.04	4.1	0.0	16.1	38	19.9	18.2	17.5	7.0	151	0.00	0.0
56	Jan/06	18.5	Brown	Odour free	440	8.2		0.01	5.9	0.0	18.6	41	24.1	20.6	19.6	7.8	185	0.00	0.1
57	Feb/06	18.0	Clear	Odour free	430	8.0	0.56	0.00	3.9	0.0	30.4	40	19.9	26.4	18.6	7.0	176	0.00	0.1
58	Mar/06	24.5	Clear	Odour free	370	8.4	0.84	0.00	4.3	14.4	34.0	52	18.1	23.0	22.7	10.6	171	0.29	0.0
59	Apr/06	26.5	Brown	Odour free	430	8.1	0.98	0.04	4.1	0.0	38.4	55	22.0	26.4	24.8	11.7	181	0.25	0.1
60	May/06	33.0	Brown	Odour free	560	8.4	0.98	0.06	5.5	14.4	42.3	58	25.9	28.3	26.9	13.3	190	0.32	0.2
61	Jun/06	34.0	Brown	Odour free	620	7.8	0.95	0.08	6.3	0.0	45.1	62	28.1	33.1	29.9	10.6	200	0.30	0.3
62	Jul/06	33.5	Brown	Odour free	470	8.0	0.70	0.10	5.9	0.0	38.9	40	19.9	26.4	20.7	10.2	185	0.23	0.2
63	Aug/06	32.0	Brown	Odour free	210	7.9	0.48	0.03	4.7	0.0	13.8	29	22.0	16.3	18.6	0.7	112	0.17	0.1
64	Sep/06	31.0	Brown	Odour free	220	8.2	0.56	0.03	4.1	0.0	14.0	31	13.9	17.3	19.6	6.7	117	0.21	0.1
65	Oct/06	32.5	Brown	Odour free	410	8.4	0.88	0.03	4.7	19.2	25.8	38	25.9	25.9	23.7	12.5	161	0.27	0.2
66	Nov/06	27.5	Brown	Odour free	390	8.1	0.77	0.04	5.1	0.0	23.0	36	22.0	24.5	21.6	23.5	156	0.23	0.2
67	Dec/06	20.0	Brown	Odour free	400	8.4	1.06	0.04	6.3	14.4	25.1	40	24.1	25.4	21.6	12.5	161	0.29	0.2
68	Jan/07	17.0	Brown	Odour free	420	8.1	1.18	0.04	4.2	0.0	25.8	41	25.9	26.9	22.7	13.3	171	0.30	0.2
69	Feb/07	21.5	Brown	Odour free	360	8.4	1.06	0.04	4.1	0.0	22.3	38	22.0	25.9	17.5	11.7	146	0.25	0.0
70	Mar/07	23.0	Brown	Odour free	380	7.9	1.18	0.04	3.8	0.0	23.2	40	24.1	26.9	18.6	12.1	151	0.29	0.1
71	Apr/07	29.0	Brown	Odour free	400	8.0	1.43	0.06	3.8	0.0	24.6	41	22.0	27.8	20.7	12.5	181	0.34	0.1
72	May/07	31.0	Brown	Odour free	560	8.2	1.78	0.06	6.4	0.0	28.1	46	25.9	30.2	24.8	13.3	200	0.42	0.2
73	Jun/07	32.5	Clear	Odour free	470	8.1	1.60	0.06	6.8	0.0	26.9	41	22.0	28.3	22.7	10.2	185	0.34	0.1
74	Jul/07	33.0	Brown	Odour free	310	7.9	1.47	0.04	5.5	0.0	18.4	36	16.0	23.5	19.6	7.4	161	0.30	0.1
75	Aug/07	30.5	Brown	Odour free	200	8.2	0.67	0.04	3.7	0.0	7.4	31	9.9	17.8	16.5	4.7	146	0.29	0.1
76	Sep/07	32.5	Brown	Odour free	270	7.7	0.67	0.07	4.3	0.0	8.7	34	16.0	20.2	18.6	5.5	151	0.30	0.2
77	Oct/07	31.5	Brown	Odour free	380	7.7	0.80	0.07	5.6	0.0	20.7	40	19.9	23.0	21.6	9.0	195	0.38	0.2
78	Nov/07	27.5	Brown	Odour free	400	7.9	0.83	0.08	4.6	0.0	21.4	41	24.1	23.5	22.7	9.8	200	0.44	0.2
79	Dec/07	24.0	Brown	Odour free	420	7.8	0.84	0.08	5.4	0.0	22.1	43	25.9	25.0	23.7	10.6	205	0.46	0.3
80	Jan/08	16.0	Brown	Odour free	430	7.9	0.87	0.08	5.4	0.0	22.8	45	28.1	25.4	24.8	11.0	205	0.55	0.2
81	Feb/08	15.5	Brown	Odour free	400	7.8	0.84	0.08	5.4	0.0	22.1	43	24.1	24.5	23.7	9.8	195	0.32	0.2
82	Mar/08	23.0	Brown	Odour free	420	8.0	0.88	0.08	5.6	0.0	22.3	45	25.9	25.0	24.8	10.2	205	0.65	0.2
83	Apr/08	27.0	Brown	Odour free	590	7.5	0.95	0.10	4.7	0.0	23.7	48	32.0	26.9	26.9	11.7	215	0.70	0.3
84	May/08	30.0	Brown	Odour free	530	8.0	0.88	0.07	6.3	0.0	22.5	45	25.9	22.6	24.8	10.6	205	0.61	0.2
85	Jun/08	30.5	Clear	Odour free	580	7.6	0.98	0.08	6.7	0.0	23.0	41	32.0	23.5	24.8	11.3	210	0.63	0.2
86	Jul/08	32.5	Brown	Odour free	260	7.8	0.78	0.00	4.8	0.0	9.2	31	16.0	13.9	16.5	4.7	171	0.44	0.1

87	Aug/08	31.5	Brown	Odour free	250	7.7	0.84	0.00	3.8	0.0	8.5	29	16.0	14.9	15.4	3.5	119	0.42	0.1
88	Sep/08	32.5	Brown	Odour free	280	7.5	0.91	0.06	4.5	0.0	9.7	33	16.0	16.8	17.5	4.3	127	0.49	0.1
89	Oct/08	31.0	Brown	Odour free	220	8.2	0.77	0.04	3.9	0.0	8.3	29	13.9	13.9	15.4	3.9	117	0.42	0.1
90	Nov/08	26.0	Brown	Odour free	230	7.9	0.84	0.06	4.0	0.0	8.5	31	16.0	15.8	16.5	4.3	122	0.46	0.1
91	Dec/08	20.5	Brown	Odour free	430	8.3	1.02	0.11	4.4	0.0	12.2	38	22.0	21.6	20.7	6.3	151	0.59	0.0
92	Jan/09	18.0	Brown	Odour free	400	8.1	1.11	0.07	4.2	0.0	11.7	29	18.1	20.2	18.6	5.9	146	0.55	0.0
93	Feb/09	19.5	Brown	Odour free	460	8.3	1.09	0.10	4.4	19.2	12.4	35	19.9	22.1	22.1	6.3	122	0.61	0.1
94	Mar/09	23.0	Brown	Odour free	440	8.5	1.06	0.08	4.8	19.2	12.2	36	22.0	21.1	19.6	5.9	117	0.57	0.1
95	Apr/09	27.5	Brown	Odour free	470	8.1	1.15	0.10	6.4	0.0	12.9	38	24.1	22.6	20.7	6.7	161	0.63	0.1
96	May/09	29.5	Brown	Odour free	530	8.3	1.43	0.12	7.2	0.0	13.6	41	25.9	24.5	22.7	7.0	171	0.70	0.2
97	Jun/09	32.0	Brown	Odour free	380	8.2	1.18	0.10	5.8	0.0	11.5	36	19.9	18.2	20.7	6.3	156	0.59	0.0
98	Jul/09	32.0	Brown	Odour free	450	8.3	1.32	0.14	6.5	0.0	12.2	40	22.0	20.2	22.7	7.0	166	0.65	0.2
99	Aug/09	32.0	Brown	Odour free	300	8.0	1.13	0.12	5.2	0.0	10.6	36	19.9	17.3	20.7	6.3	156	0.59	0.1
100	Sep/09	32.5	Brown	Odour free	270	8.3	1.05	0.10	3.1	0.0	9.4	36	18.1	15.8	19.6	5.9	151	0.53	0.1
101	Oct/09	32.0	Brown	Odour free	290	8.4	1.13	0.11	2.9	14.4	9.9	36	18.1	16.3	20.7	6.3	156	0.59	0.2
102	Nov/09	24.0	Brown	Odour free	270	8.6	1.08	0.10	4.5	19.2	10.1	34	16.0	15.8	19.6	6.7	151	0.53	0.2
103	Dec/09	19.5	Brown	Odour free	340	7.8	1.32	0.11	5.1	0.0	13.8	36	22.0	18.7	22.7	7.0	195	0.61	0.2
104	Jan/10	17.5	Brown	Odour free	280	8.3	1.02	0.07	5.1	0.0	10.6	34	18.1	16.3	21.6	6.3	185	0.55	0.2
105	Feb/10	19.0	Brown	Odour free	410	7.8	1.26	0.11	5.9	0.0	11.5	38	19.9	18.2	22.7	7.4	195	0.63	0.2
106	Mar/10	23.5	Brown	Odour free	530	8.3	1.54	0.14	6.7	0.0	13.3	38	22.0	20.6	22.7	8.6	215	0.70	0.3
107	Apr/10	28.0	Brown	Odour free	570	8.7	1.70	0.15	7.7	24.0	20.2	41	27.7	23.0	22.7	11.3	225	0.74	0.4
108	May/10	31.5	Brown	Odour free	640	8.7	1.89	0.18	8.6	14.4	16.1	43	25.9	22.6	24.8	10.2	234	0.82	0.4
109	Jun/10	32.0	Brown	Odour free	560	8.7	2.17	0.12	9.4	0.0	15.9	41	24.1	21.1	22.7	9.8	260	0.78	0.0
110	Jul/10	32.0	Brown	Odour free	570	8.4	2.10	0.15	10.2	19.2	15.4	43	24.1	22.1	23.7	9.4	234	0.80	0.0
111	Aug/10	30.5	Brown	Odour free	270	7.7	0.74	0.07	2.9	0.0	12.4	31	19.9	7.2	17.5	7.4	185	0.27	0.0
112	Sep/10	30.0	Brown	Odour free	260	8.1	0.70	0.06	1.7	0.0	12.0	29	18.1	6.2	16.5	7.0	176	0.25	0.0
113	Oct/10	30.0	Brown	Odour free	280	7.7	0.83	0.07	2.2	0.0	12.2	31	19.9	7.2	19.6	7.4	185	0.27	0.0
114	Nov/10	27.0	Brown	Odour free	350	8.1	0.87	0.10	2.0	0.0	14.3	34	22.0	8.2	22.7	7.0	220	0.32	0.0
115	Dec/10	24.5	Brown	Odour free	350	8.3	0.85	0.07	2.6	14.4	12.2	33	19.9	7.2	21.6	6.7	215	0.29	0.0
116	Jan/11	18.0	Clear	Odour free	380	7.7	1.36	0.10	3.5	0.0	14.5	36	22.0	8.2	23.7	7.0	234	0.32	0.0
117	Feb/11	18.0	Brown	Odour free	390	8.2	1.51	0.12	3.9	0.0	14.5	40	24.1	7.2	23.7	7.8	249	0.36	0.0
118	Mar/11	21.0	Brown	Odour free	460	8.5	1.63	0.15	5.9	19.2	15.6	45	28.1	8.6	24.8	8.2	264	0.44	0.0
119	Apr/11	21.5	Brown	Odour free	450	8.4	1.42	0.12	6.3	28.8	15.9	43	25.9	7.2	24.8	9.0	259	0.40	0.0
120	May/11	31.0	Brown	Odour free	350	8.7	1.29	0.10	6.7	14.4	13.3	40	22.0	5.3	22.7	8.6	254	0.36	0.0

Annex - VII

Water Quality Data of River Ganga at Bhitaura for the period June 2001- May 2011[#]

 # WQ Stations Established by Central Water Commission on River Ganga at Downstream of Unnao, UP.

S.No.	Date	Temp (^{0}C)	Colour	Odour	EC (µmho/cm)	pH	NO3-N (mg/L)	NO2-N (mg/L)	BOD3-27 (mg/L)	CO3 (mg/L)	Na (mg/L)	Ca (mg/L)	Cl (mg/L)	SO4 (mg/L)	Mg (mg/L)	K (mg/L)	HCO3(mg/L)	F (mg/L)	Fe (mg/L)
1	June/01	30.0	Brown	Odour free	350	8.2		0.00		0.0	6.2	33	19.9	15.4	13.4	5.1	181	0.11	0.0
2	July/01	27.0	Brown	Odour free	550	8.1		0.01		0.0	6.0	34	19.9	9.1	15.4	5.1	137	0.10	0.0
3	Aug./01	29.5	Clear	Odour free	200	8.2		0.00		0.0	5.8	33	18.1	7.2	0.2	4.7	107	0.00	0.0
4	Sep./01	31.0	Clear	Odour free	250	8.1		0.00		0.0	6.2	36	22.0	11.5	15.4	5.1	137	0.00	0.0
5	Oct./01	31.0	Clear	Odour free	380	8.1		0.00		0.0	7.1	40	28.1	14.4	17.5	5.9	200	0.00	0.0
6	Nov./01	28.0	Clear	Odour free	500	8.0		0.00		0.0	6.9	41	28.1	12.0	18.6	5.5	259	0.00	0.0
7	Dec./01	20.0	Clear	Odour free	470	8.1		0.00		0.0	7.4	40	25.9	10.1	17.5	6.3	239	0.00	0.0
8	Jan./02	16.5	Clear	Odour free	420	8.2		0.00		0.0	6.2	38	24.1	11.5	18.6	5.5	220	0.00	0.0
9	Feb../02	18.0	Clear	Odour free	440	8.1		0.00		0.0	6.9	41	25.9	12.0	19.6	5.9	225	0.00	0.0
10	Mar./02	19.5	Clear	Odour free	400	8.2		0.00		0.0	7.1	40	28.1	11.5	18.6	5.9	210	0.10	0.0
11	Apr./02	19.5	Clear	Odour free	530	8.1		0.01		0.0	9.4	43	32.0	14.4	20.7	7.0	273	0.19	0.1
12	May/02	29.0	Clear	Odour free	600	8.0		0.01		0.0	9.7	45	34.1	16.3	21.6	7.8	307	0.40	0.2
13	June/02	33.0	Clear	Odour free	320	8.1		0.00		0.0	7.8	40	28.1	13.0	19.6	6.3	171	0.40	0.0
14	July/02	33.5	Clear	Odour free	280	8.2		0.00		0.0	7.4	33	24.1	10.1	13.4	6.3	151	0.00	0.0
15	Aug./02	33.0	Clear	Odour free	300	8.0		0.00		0.0	7.8	34	24.1	7.7	15.4	7.0	156	0.15	0.0
16	Sep./02	34.0	Clear	Odour free	400	7.9		0.00		0.0	8.7	38	28.1	7.7	19.6	7.4	210	0.29	0.2
17	Oct./02	32.0	Brown	Odour free	300	8.0		0.21		0.0	8.5	40	24.1	8.2	20.7	7.8	161	0.44	0.2
18	Nov./02	28.0	Clear	Odour free	450	7.7		0.21		0.0	9.7	41	25.9	11.0	21.6	8.2	234	0.29	0.3
19	Dec./02	20.5	Clear	Odour free	360	8.0		0.00		0.0	9.4	38	24.1	8.6	19.6	8.2	185	0.29	0.0
20	Jan./03	18.5	Clear	Odour free	300	7.8		0.00		0.0	9.2	36	22.0	8.6	18.6	7.8	181	0.29	0.0
21	Feb./03	20.5	Clear	Odour free	470	8.1		0.22		0.0	16.8	40	25.9	13.4	20.7	11.3	244	0.59	0.0
22	Ma./03	26.0	Clear	Odour free	330	8.2		0.00		0.0	12.9	38	24.1	10.1	18.6	6.7	181	0.00	0.0
23	Apr./03	27.5	Clear	Odour free	590	8.2		0.00		0.0	26.5	41	32.0	14.9	25.8	7.0	307	0.59	0.0
24	May/03	29.0	Clear	Odour free	600	8.0		0.00		0.0	26.0	24	30.2	16.8	27.7	7.0	303	0.59	0.2

25	June/03	32.0	Clear	Odour free	560	8.1		0.11		0.0	10.6	36	28.1	14.9	27.8	6.7	293	0.40	0.1
26	July/03	33.5	Clear	Odour free	280	8.1		0.00		0.0	12.0	34	22.0	10.1	16.5	5.9	132	0.00	0.0
27	Aug./03	32.0	Other	Odour free	240	8.1		0.00		0.0	11.3	31	22.0	13.0	14.5	5.1	146	0.00	0.0
28	Sep./03	34.0	Brown	Odour free	210	8.0		0.00		0.0	6.9	28	19.9	11.0	23.7	5.9	137	0.00	0.0
29	Oct./03	31.5	Other	Odour free	230	7.9		0.00		0.0	8.1	33	22.0	12.0	15.4	6.3	141	0.44	0.0
30	Nov./03	29.0	Other	Odour free	400	7.9		0.00		0.0	9.2	38	25.9	13.4	17.5	7.0	151	0.29	0.0
31	Dec./03	20.0	Clear	Odour free	460	7.9		0.00		0.0	17.7	40	28.1	14.9	18.6	7.8	156	0.29	0.0
32	Jan./04	17.0	Clear	Odour free	420	7.8		0.00		0.0	17.3	36	24.1	12.5	16.5	7.4	142	0.00	0.0
33	Feb./04	18.0	Brown	Odour free	440	8.1		0.00		0.0	17.5	36	25.9	13.0	17.5	7.4	146	0.00	0.0
34	Mar./04	26.0	Brown	Odour free	530	7.9		0.00		0.0	18.9	41	32.0	13.4	19.6	8.2	225	0.00	0.0
35	Apr./04	27.0	Other	Odour free	590	7.9		0.00		0.0	22.1	46	38.0	16.3	22.7	8.2	303	0.00	0.0
36	May/04	19.0	Green	Odour free	650	8.0		0.00		0.0	23.5	50	41.9	19.7	25.8	9.0	332	0.00	0.0
37	June/04	21.0	Other	Odour free	700	8.0		0.01		0.0	23.7	42	44.0	18.2	26.9	9.4	337	0.00	0.0
38	July/04	21.0	Brown	Odour free	380	7.9		0.00		0.0	11.7	38	30.2	13.9	19.6	6.3	171	0.00	0.0
39	Aug./04	19.5	Brown	Odour free	300	7.9		0.00		0.0	7.1	34	25.9	12.0	17.5	5.1	151	0.00	0.0
40	Sep./04	18.0	Brown	Odour free	260	7.9		0.00		0.0	6.4	36	22.0	16.8	18.6	4.3	142	0.00	0.0
41	Oct./04	5.5	Brown	Odour free	330	8.0		0.00		0.0	8.1	38	25.9	20.6	20.7	5.1	171	0.00	0.0
42	Nov./04	22.0	Brown	Odour free	460	7.9		0.00		0.0	10.4	40	30.2	27.4	26.9	6.3	244	0.00	0.0
43	Dec./04	17.5	Brown	Odour free	430	8.0		0.00		0.0	10.1	38	25.9	25.0	24.8	5.9	229	0.00	0.0
44	Jan./05	16.5	Brown	Odour free	500	8.1		0.00		0.0	11.3	40	30.2	31.2	21.6	7.0	239	0.00	0.0
45	Feb./05	15.0	Brown	Odour free	490	8.0		0.00		0.0	10.8	36	28.1	29.8	18.6	6.3	234	0.00	0.0
46	Mar./05	16.0	Brown	Odour free	660	7.7		0.01		0.0	15.4	46	36.2	38.9	23.7	8.2	278	0.13	0.0
47	Apr./05	28.5	Clear	Odour free	640	8.1		0.03		0.0	17.3	50	34.1	32.6	25.8	9.0	273	0.25	0.0
48	May/05	31.0	Clear	Odour free	650	8.1		0.03		0.0	19.8	52	28.1	26.4	27.8	10.2	259	0.29	0.5
49	June/05	29.0	Green	Odour free	680	8.0		0.03		0.0	28.8	55	28.1	27.8	31.0	11.0	264	0.34	0.2
50	July/05	30.0	Brown	Odour free	630	8.0		0.01		0.0	28.1	52	24.1	25.4	28.9	10.2	225	0.59	0.2
51	Aug./05	29.0	Brown	Odour free	270	8.0		0.01		0.0	16.1	31	16.0	18.7	14.5	5.1	146	0.74	0.0
52	Sep./05	31.5	Brown	Odour free	290	8.0		0.01		0.0	16.3	33	18.1	19.2	15.4	5.5	151	0.00	0.0
53	Oct./05	30.0	Brown	Odour free	260	8.0		0.01		0.0	16.1	29	18.1	16.3	13.4	5.1	142	0.00	0.0
54	Nov./05	27.0	Brown	Odour free	360	7.8		0.00		0.0	16.3	33	19.9	18.2	15.4	5.9	156	0.00	0.0
55	Dec./05	19.5	Brown	Odour free	400	8.1		0.04		0.0	18.4	34	22.0	18.7	17.5	6.7	161	0.00	0.0
56	Jan./06	15.0	Brown	Odour free	400	8.2		0.00		0.0	17.5	33	19.9	18.7	16.5	6.3	156	0.00	0.0

57	Feb./06	15.5	Clear	Odour free	460	8.0	0.42	0.00		0.0	29.2	36	24.1	40.8	18.6	7.0	166	0.21	0.0
58	Mar./06	23.0	Clear	Odour free	380	8.0	0.42	0.00		0.0	25.3	33	28.1	25.9	16.5	6.7	151	0.19	0.0
59	Apr./06	25.5	Brown	Odour free	450	7.9	0.42	0.08		0.0	31.7	36	30.2	30.2	18.6	9.8	181	0.30	0.1
60	May/06	29.0	Brown	Odour free	660	8.4	0.42	0.08		19.2	35.7	40	22.0	33.1	20.7	11.0	215	0.36	0.2
61	June/06	31.5	Brown	Odour free	660	7.9	3.50	0.10		0.0	34.3	38	19.9	31.7	19.6	10.2	210	0.34	0.4
62	July/06	31.5	Brown	Odour free	530	7.5	2.66	0.12		0.0	26.7	36	18.1	24.5	19.6	8.2	200	0.27	0.2
63	Aug./06	29.5	Brown	Odour free	220	7.9	1.77	0.03		0.0	13.6	31	22.0	17.3	17.5	6.7	122	0.21	0.1
64	Sep./06	30.0	Other	Odour free	210	7.7	1.70	0.03		0.0	13.1	29	9.9	16.8	16.5	6.3	117	0.17	0.1
65	Oct./06	30.5	Brown	Odour free	370	7.9	0.97	0.03		0.0	23.2	34	18.1	28.8	20.7	11.3	151	0.29	0.2
66	Nov./06	28.0	Other	Odour free	410	7.8	1.11	0.04		0.0	25.5	40	22.0	30.2	20.7	13.3	166	0.25	0.3
67	Dec./06	20.5	Other	Odour free	460	8.1	1.04	0.04		0.0	30.1	45	24.1	32.6	25.8	16.0	195	0.32	0.3
68	Jan./07	16.0	Brown	Odour free	450	7.8	1.02	0.06		0.0	28.8	43	22.0	32.2	24.8	15.3	190	0.30	0.2
69	Feb./07	14.5	Brown	Odour free	390	8.3	2.03	0.04		14.4	25.1	43	18.1	31.7	24.8	12.9	171	0.27	0.2
70	Mar./07	21.0	Brown	Odour free	360	7.8	1.77	0.04		0.0	23.9	41	16.0	30.2	18.6	11.3	195	0.25	0.2
71	Apr./07	22.0	Brown	Odour free	360	7.9	1.43	0.04		0.0	23.0	41	16.0	29.8	20.7	11.0	151	0.23	0.1
72	May/07	32.0	Brown	Odour free	510	8.2	1.77	0.06		0.0	27.4	106	18.1	33.6	24.8	12.9	156	0.34	0.3
73	June/07	30.5	Brown	Odour free	650	8.1	1.88	0.07		0.0	34.7	53	28.1	40.3	35.1	13.3	176	0.40	0.4
74	July/07	30.5	Brown	Odour free	310	7.9	1.60	0.06		0.0	20.0	43	22.0	29.3	20.7	7.8	142	0.32	0.1
75	Aug./07	30.0	Brown	Odour free	200	8.1	1.70	0.04		0.0	7.8	34	13.9	23.0	15.4	4.7	119	0.27	0.1
76	Sep./07	30.0	Brown	Odour free	260	7.7	1.70	0.03		0.0	13.1	29	9.9	16.8	16.5	6.3	117	0.17	0.1
77	Oct./07	28.0	Brown	Odour free	380	7.6	1.92	0.07		0.0	21.4	40	19.9	25.4	20.7	10.6	195	0.36	0.2
78	Nov./07	24.5	Brown	Odour free	400	8.0	1.96	0.07		0.0	22.1	45	22.0	26.4	18.6	11.0	200	0.38	0.2
79	Dec./07	20.0	Brown	Odour free	440	7.7	2.06	0.08		0.0	22.8	48	24.1	26.9	23.7	11.3	210	0.42	0.3
80	Jan./08	16.0	Brown	Odour free	460	8.0	1.99	0.10		0.0	23.2	21	25.9	27.8	25.8	12.5	220	0.61	0.3
81	Feb./08	15.5	Other	Odour free	460	8.3	1.98	0.10		9.6	22.8	49	24.1	25.9	24.8	12.1	215	0.59	0.2
82	Mar./08	17.5	Other	Odour free	480	8.1	2.00	0.10		0.0	23.0	52	25.9	26.4	25.8	12.5	195	0.72	0.3
83	Apr./08	24.0	Other	Odour free	710	7.7	2.08	0.11		0.0	26.7	57	32.0	28.8	28.9	14.5	249	0.78	0.3
84	May/08	29.0	Other	Odour free	660	8.1	1.92	0.10		0.0	24.8	53	25.9	26.9	26.9	13.3	244	0.65	0.2
85	June/08	30.5	Other	Odour free	700	7.8	2.10	0.11		0.0	20.7	57	28.1	28.3	28.9	13.7	249	0.68	0.2
86	July/08	28.5	Brown	Odour free	530	8.6	0.85	0.00		0.0	16.1	50	22.0	22.1	25.8	11.3	234	0.42	0.1
87	Aug./08	29.5	Brown	Odour free	240	7.7	0.67	0.00		0.0	9.7	34	13.9	13.9	19.0	6.7	166	0.32	0.1
88	Sep./08	30.5	Brown	Odour free	390	7.6	0.85	0.10		0.0	18.4	40	25.9	20.2	22.7	8.2	176	0.42	0.3

89	Oct./08	29.0	Brown	Odour free	230	8.2	0.59	0.04		0.0	10.4	33	13.9	13.9	18.6	6.7	161	0.29	0.2
90	Nov./08	28.0	Brown	Odour free	370	7.8	0.67	0.10		0.0	15.0	40	19.9	20.2	23.7	8.2	205	0.36	0.2
91	Dec./08	22.0	Brown	Odour free	440	8.1	0.74	0.10		0.0	18.4	45	24.1	25.9	27.8	9.4	215	0.42	0.3
92	Jan./09	17.0	Brown	Odour free	430	8.1	0.70	0.07		0.0	17.3	43	26.6	24.0	27.0	9.0	210	0.40	0.2
93	Feb./09	17.0	Brown	Odour free	450	8.2	0.84	0.08		0.0	20.2	47	28.4	25.0	27.8	9.4	220	0.44	0.3
94	Mar./09	17.5	Other	Odour free	470	8.4	0.85	0.10		19.2	19.6	50	25.9	26.4	28.9	10.2	225	0.48	0.4
95	Apr./09	23.0	Brown	Odour free	580	7.8	1.18	0.14		0.0	22.1	52	30.2	29.3	32.0	11.7	278	0.57	0.4
96	May/09	26.0	Brown	Odour free	650	8.1	1.33	0.15		0.0	23.7	55	34.1	31.7	34.0	12.9	293	0.65	0.5
97	June/09	27.5	Light Green	Odour free	460	8.1	1.08	0.12		0.0	17.3	48	28.1	27.4	31.0	9.8	244	0.55	0.4
98	July/09	29.5	Clear	Odour free	590	8.1	1.29	0.17		0.0	20.0	55	36.2	29.8	34.0	12.5	278	0.70	0.4
99	Aug./09	28.0	Brown	Odour free	370	7.6	1.04	0.12		0.0	17.5	50	30.2	22.6	31.0	11.0	234	0.59	0.3
100	Sep./09	26.0	Brown	Odour free	320	7.9	0.92	0.10		0.0	15.2	45	24.1	20.6	27.8	8.6	229	0.46	0.2
101	Oct./09	24.0	Brown	Odour free	290	8.3	1.02	0.12		0.0	15.9	34	28.1	21.6	19.6	9.0	234	0.49	0.3
102	Nov./09	20.5	Brown	Odour free	260	8.4	0.95	0.10		14.4	15.4	45	25.9	20.6	27.8	8.6	229	0.46	0.4
103	Dec./09	16.0	Light Brown	Odour free	340	8.1	1.25	0.11		19.2	16.3	46	32.0	21.6	28.9	9.8	244	0.51	0.3
104	Jan./10	14.0	Light Brown	Odour free	280	8.3	1.08	0.07		0.0	16.1	43	28.1	20.6	18.6	9.4	273	0.44	0.4
105	Feb./10	13.0	Brown	Odour free	430	8.2	1.25	0.10		0.0	18.4	48	30.2	22.6	28.9	11.3	283	0.61	0.4
106	Mar./10	16.0	Light Brown	Odour free	580	7.9	1.49	0.12	4.1	0.0	21.4	50	34.1	25.0	28.9	12.5	288	0.68	0.4
107	Apr./10	21.0	Light Brown	Odour free	540	8.5	1.40	0.10	5.5	24.0	19.6	48	30.2	25.9	27.8	11.3	278	0.65	0.4
108	May/10	30.5	Light Brown	Odour free	600	8.7	1.71	0.12	2.6	19.2	20.2	50	32.0	27.4	28.9	12.1	283	0.70	0.4
109	June/10	30.0	Clear	Odour free	730	8.7	2.31	0.17	7.1	14.4	25.1	53	25.9	35.5	31.0	12.5	303	0.76	
110	July/10	30.0	Brown	Odour free	840	8.5	2.66	0.19	7.7	24.0	25.8	48	41.9	37.9	27.8	12.9	293	0.82	
111	Aug./10	29.0	Brown	Odour free	270	7.7	1.02	0.10	2.4	0.0	17.5	24	28.1	7.2	13.4	8.2	146	0.29	
112	Sep./10	30.0	Brown	Odour free	260	8.3	0.98	0.07	1.4	0.0	17.0	22	25.9	6.7	12.4	7.4	142	0.27	
113	Oct./10	28.0	Brown	Odour free	290	8.1	1.28	0.10	1.4	0.0	17.5	26	28.1	7.2	13.4	7.8	151	0.30	
114	Nov./10	24.0	Clear	Odour free	340	8.2	1.47	0.12	1.6	0.0	20.0	29	32.0	8.2	15.4	8.2	171	0.36	
115	Dec./10	19.0	Clear	Odour free	330	8.3	1.40	0.10	2.2	0.0	19.1	28	30.2	8.6	14.5	8.2	161	0.32	
116	Jan./11	15.0	Clear	Odour free	360	7.6	1.15	0.12	3.1	0.0	20.0	31	32.0	9.6	16.5	8.6	185	0.40	
117	Feb./11	14.0	Clear	Odour free	450	8.0	1.43	0.15	3.5	0.0	23.0	34	36.2	11.0	18.6	9.4	205	0.46	
118	Mar./11	20.0	Brown	Odour free	400	8.2	1.33	0.12	5.5	0.0	20.7	33	32.0	10.1	17.5	8.2	190	0.40	
119	Apr./11	23.5	Clear	Odour free	480	8.2	1.54	0.15	5.9	0.0	22.5	36	36.2	11.5	19.6	9.0	215	0.49	
120	May/11	24.0	Clear	Odour free	370	8.1	1.33	0.97	6.3	0.0	19.6	33	32.0	8.6	17.5	8.6	185	0.40	

Annex - VIII

Health Impacts of Various Contaminants

Contaminant/Pollutant	Health Impact
TDS	Gastro intestinal irritation
TSS	Gastro intestinal infection
Hardness	Deposition of calcium in nerves, formation of stones, stomach disorder
Sulphate	Gastro intestinal irritation
Nitrate	Methaemoglobinemia
Fluoride	Dental and skelatal fluorosis
BOD & COD	Excessive bacterial production
Copper	Damage of liver
Nickel	Lung cancer, cancer of nasal sinus
Chromium	Liver, kidney and respiratory organs with hemorrhagic effects, dermatitis and ulceration of the skin
Lead	Constipation, anemia, gastrointestinal disturbance, tenderness and gradual paralysis in muscles, specifically arms with possible cases of lethargy and moroseness
Cadmium	High blood pressure, kidney damage and destruction of testicular tissue and red blood cells
Zinc	Vomiting, dehydration, electrolyte imbalance, abdominal pain, nausea lethargyness, dizziness and lack of muscular coordination
Arsenic	Skin and lung carcinogen
Mercury	Kidneys, neurological and renal disturbances

Annex - IX

General Standards for Discharge of Environmental Pollutants Part-A: Effluents

S. No.	Parameter	Standards			
		Inland Surface	Public Sewers	Land for Irrigation	Marine /coastal areas
		(a)	(b)	(c)	(d)
1.	Colour and odour	See 6 of Annexure-1	-	See 6 of Annexure-1	See 6 of Annexure-1
2.	Suspended Solids (mg/L), max	100	600	200	a. For process waste water. b. For cooling water effluent 10 percent above total suspended matter in influent.
3.	Particle size of suspended solids	shall pass 850 micron IS Sieve			a. Floatable solids, max. 3mm. b. Settle able solids, max. 856 microns
4.	pH value	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0
5.	Temperature	Shall not exceed 5°C above the receiving water temperature	-	-	Shall not exceed 5°C above the receiving water temperature
6.	Oil and grease mg/L, max.	10	20	10	20
7.	Total residual chlorine, mg/L max.	1.0	-	-	1.0
8.	Ammonical nitrogen (as N), mg/L max.	50	50	-	50
9.	Total Kjeldahl Nitrogen (TKN) (as N), mg/L max.	100	-	-	100
10.	Free ammonia (as NH_3), mg/L, max	5.0	-	-	5.0
11.	Biochemical Oxygen Demand (3 days at 27°C), mg/L, max.	30	350	100	100
12.	Chemical Oxygen Demand, mg/L, max.	250	-	-	250
13.	Arsenic (as As), mg/L, max.	0.2	0.2	0.2	0.2
14.	Mercury (as Hg), mg/L, max.	0.01	0.01	-	0.01
15.	Lead (as Pb), mg/L, max.	0.1	1.0	-	2.0
16.	Cadmium (as Cd) mg/L, max	2.0	1.0	-	2.0
17.	Hexavalent Chromium (as Cr^{+6}) mg/L, max	0.1	2.0	-	1.0
18.	Total Chromium (as Cr) mg/L, max.	2.0	2.0	-	2.0
19.	Copper (as Cu) mg/L, max.	3.0	3.0	-	3.0
20.	Zinc (as Zn) mg/L, max.	5.0	15.0	-	15.0
21.	Selenium (as Se) mg/L, max.	0.05	0.05	-	0.05
22.	Nickel (as Ni) mg/L, max.	3.0	3.0	-	5.0
23.	Cyanide (as CN) mg/L, max.	0.2	2.0	0.2	0.2
24.	Fluoride (as F) mg/L, max.	2.0	15.0	-	15.0
25.	Dissolved phosphates (as P) mg/L, max.	5.0	-	-	-

26.	Sulphide (as S) mg/L, max.	2.0	-	-	5.0
27.	Phenolic compounds (as C_6H_5OH) mg/L, max.	1.0	5.0	-	5.0
28.	Radioactive materials: Alpha emitters micro curie mg/L, max.	10^{-7}	10^{-7}	10^{-8}	10^{-7}
	Beta emitters micro curie, mg/L, max	10^{-6}	10^{-6}	10^{-7}	10^{-6}
29.	Bio-assay	90 % survival of fish after 96 hours in 100 % effluent	90 % survival of fish after 96 hours in 100 % effluent	90 % survival of fish after 96 hours in 100 % effluent	90 % survival of fish after 96 hours in 100 % effluent
30.	Manganese (as Mn) mg/L, max.	2.0	2.0	-	2.0
31.	Iron (as Fe) mg/L, max.	3.0	3.0	-	3.0
32.	Vanadium (as V) mg/L, max.	0.2	0.2	-	0.2
33.	Nitrate nitrogen(as N) mg/L, max.	10.0	-	-	20

Note:

1. "6 of Annexure 1" states "All efforts should be made to remove colour and unpleasant odour as far as practicable." These standards shall be applicable for industries, operations or processes other than those industries, operations or processes for which standards have been specified in Schedule of the Environment Protection Rules, 1989.

Annex - X

Drinking Water Specifications (IS 10500:1991)

S.No.	Characteristics	Requirement (Desirable Limit)	Permissible Limit in the Absence of Alternate Source
Essential Characteristics			
1.	Colour, Hazen units, Max	5	25
2.	Odour	Unobjectionable	-
3.	Taste	Agreeable	-
4.	Turbidity, NTU, Max	5	10
5.	pH value	6.5 to 8.5	No relaxation
6.	Total hardness ($CaCO_3$), mg/L, Max	300	600
7.	Iron, mg/L, Max	0.3	1.0
8.	Chlorides, mg/L, Max	250	1000
9.	Residual chlorine, mg/L, Min	0.2	-
10.	Fluoride, mg/L, Max	1.0	1.5
Desirable Characteristics			
11.	Dissolved solids, mg/L, Max	500	2000
12.	Calcium (as Ca), mg/L, Max	75	200
13.	Magnesium (as Mg), mg/L, Max	30	100
14.	Copper (as Cu), mg/L, Max	0.05	1.5
15.	Manganese (as Mn), mg/L, Max	0.1	0.3
16.	Sulphate (as SO_4), mg/L, Max	200	400
17.	Nitrate (as NO_3), mg/L, Max	45	No relaxation
18.	Phenolic compounds (as C_6H_5OH), mg/L, Max	0.001	0.002
19.	Mercury (as Hg), mg/L, Max	0.001	No relaxation
20.	Cadmium (as Cd), mg/L, Max	0.01	No relaxation
21.	Selenium (as Se), mg/L, Max	0.01	No relaxation
22.	Arsenic (as As), mg/L, Max	0.01	No relaxation
23.	Cyanide (as CN), mg/L, Max	0.05	No relaxation
24.	Lead (as Pb), mg/L, Max	0.05	No relaxation
25.	Zinc (as Zn), mg/L, Max	5	15
26.	Anionic detergents (as MBAS), mg/L, Max	0.2	1.0
27.	Chromium (as Cr^{6+}), mg/L, Max	0.05	No relaxation
28.	Mineral oil, mg/L, Max	0.01	0.03
30.	Pesticides, mg/L, Max	Absent	0.001
30.	Alkalinity, mg/L, Max	200	600
31.	Aluminium (as Al), mg/L, Max	0.03	0.2
32.	Boron, mg/L, Max	1	5

Source: Bureau of Indian Standards, New Delhi.