NATIONAL GANGA RIVER BASIN AUTHORITY (NGRBA)

(Ministry of Environment and Forests, Government of India)

Consultation Draft

Environmental and Social Management Framework (ESMF)

Volume I - Environmental and Social Analysis

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PROJECT DESCRIPTION

1. BACKGROUND

1. The river Ganga has significant economic, environmental and cultural value in India. Rising in the Himalayas and flowing in to the Bay of Bengal, the river traverses a course of more than 2,500 km through the plains of north and eastern India. The Ganga basin – which also extends into parts of Nepal, China and Bangladesh – accounts for 26 per cent of India's landmass, 30 per cent of its water resources and more than 40 per cent of its population. The Ganga also serves as one of India's holiest rivers whose cultural and spiritual significance transcends the boundaries of the basin.

2. Despite its importance, extreme pollution pressures pose a great threat to the biodiversity and environmental sustainability of the Ganga, with detrimental effects on both the quantity and quality of its flows. Due to increasing population in the basin and poor management of urbanization and industrial growth, river water quality has significantly deteriorated, particularly in dry seasons. Untreated sewage and industrial wastewater represent the primary sources of pollution, with only one-third of the sewage generated in the main-stem towns and cities receiving treatment before being discharged in the river.

3. Inadequate wastewater collection and treatment infrastructure/capacity provides the most immediate explanation for this failure, as evidenced by the fact that one-fourth of Ganga pollution comes from the industrial sector. Yet this issue is also intrinsically linked to poor management of the water supply and sanitation, as well as failures in pollution monitoring by Urban Local Bodies (ULBs) and other regulating institutions. Other factors, such as non-point source pollution from agriculture and livestock and poor solid waste management, also contribute to the problem. Decreased flow, common during the dry season but also fueled by substantial water extraction for irrigation contributes to poor water quality in the critical middle stretch of the river.

4. The Government of India (GoI) has undertaken clean-up initatives in the past. The most prominent of such efforts was the Ganga Action Plan, launched in 1985 later complemented by a similar plan for the Yamuna, the biggest tributary of the Ganga. These programmes have faced significant public scrutiny and, despite some gains made in slowing the rate of water quality

degradation, they have been widely perceived as failure. The main shortcomings of these initiatives were: (1) inadequate attention to institutional dimensions, including the absence of a long-tem-basin planning and implementation framework; (2) little effort made in addressing systemic weakness in the critical sectors of urban wastewater, solid waste management, environmental monitoring, regulation and water resources management; and (3) inadequate scale, coordination and prioritization of investments, with little emphasis on ensuring their sustainability. These programs also did not pay sufficient attention to the social dimensions of river clean-up, failing to recognize the importance of consultation, participation and awareness-raising.

5. The lessons drawn from these prior experience indicate that improving water quality in the Ganga cannot be achieved by plugging the infrastructure gap alone. Rather, any effective initiative will have to adopt a three-pronged approach:

- First, establishing a basin-level, multi-sectoral framework for addressing pollution in the river (including national/state policies and river basin management institutions);
- Second, making relevant institutions operational and effective (e.g. with the capacity to plan, implement and manage investments and enforce regulations); and,
- Third, implementing a phased program of prioritized infrastructure investments (with emphasis on sustainable operations and mobilization of community support)

1.2 CONSTITUTION OF NGRBA

6. As a major first step in this direction, the GoI has constituted the National Ganga River Basin Authority (NGRBA), on 20th February 2009, for comprehensive management of the river under section 3(3) of the Environment Protection Act, 1986. The NGRBA will act as a collaborative institution of central and state governments, headed by the Prime Minister. Members include key GoI ministers (Water Resources, Environment and Forests, Power, Finance, Urban Development, Science and Technology, and Planning Commission) and the Chief Ministers of the five primary basin states (Uttarakhand, Uttar Pradesh, Bihar, Jharkhand and West Bengal). The NGRBA also has representation from civil society organizations and experts across multiple relevant fields and can “co-opt” members from the other six basin states.

7. The NGRBA operates under a mandate to address both water quantity and quality aspects, through a multi-sector, river-basin approach. The NGRBA has recieved significant authority over regulatory and developmental matters, including the power to develop river-basin management plans and faciltate their implementation. The NGRBA has declared that by the year 2020 no untreated municipal sewage or industrial effluents will be discharged into the Ganga. An investment of US$ 3.2 billion is currently planned to meet this objective and the GoI has designated the Ministry of Environmental and Forests (MoEF) as the nodal agency for this program. At the state level, State Ganga River Basin Authorities (SGRBA's) have been proposed and four states (Uttar Pradesh, West Bengal, Jharkhand and Bihar) have already established such bodies. Special Purpose Vehicles (SPVs) will also be established to facilitate implementation through both the states and Urban Local Bodies (ULBs).

8. The NGRBA has a detailed implementation structure, supported by the GoI. A number of committees will provide technical and administrative support, and are named as follows: the Apex Council, the Standing Committee and the Empowered Steering Committee. The Apex Council will serve as the primary policy making committee and is headed by the Prime Minister. The Standing Committee, headed by the Finance Minister, will act as the main oversight body for projects implemented under the NGRBA. The Empowered Steerring committee will facilitate cooperation between relevant State and Central government deparments, sanctioning projects on a "fast track" priority basis. The NGRBA will also have a Mission Director who, along with a support team of relevant proffessionals, will be responsible for implementation within the NGRBA and manage the day-to-day functions of the Authority.

9. In shifting its focus from the earlier town-focused approach towards a long term, comprehensive, river basin approach, the new NGRBA initiative aims to address the shortcomings of the previous approach. The current effort acknowledges, at the outset, that large scale investments are needed to deliver the required improvements in terms of river conservation and clean up. It also recognizes that institutional, policy and regulatory reforms are required to ensure the long-term sustainability of those investments. Finally, this initative will take into account the social aspect of river conservation, giving due focus

towards the implementation of a broad-based public awareness campaign that will build political support for these efforts.

1.3 OBJECTIVES OF NGRBA

10. NGRBA has been constituted to enact the appropriate regulatory and development measures for effective conservation and pollution abatement in the river Ganga, while meeting the broader sustainable development goals. The objectives of NGRBA include, but are not limited to:

- Development of a river basin management plan;
- Regulation of activities aimed at prevention, control and abatement of pollution in Ganga to maintain its water quality, and to take measures relevant to river ecology and management in the Ganga basin states;
- Maintenance of minimum ecological flows in the river Ganga;
- Measures necessary for planning, financing and execution of programmes for abatement of pollution in the river Ganga including augmentation of sewerage infrastructure, catchment area treatment, protection of flood plains, creating public awareness;
- Collection, analysis and dissemination of information relating to environmental pollution in the river Ganga;
- Investigations and research problems of environmental pollution and conservation of the river Ganga;
- Promotion of water conservation practices including recycling and reuse, rain water harvesting, and decentralised sewage treatment systems;
- Monitoring and review of the implementation of various programmes or activities taken up for prevention, control and abatement of pollution in the river Ganga;
- Issue directions under section 5 of the Environment (Protection) Act, 1986 for the purpose of exercising and performing these functions and for achievement of its objectives.

1.4 WORLD BANK'S ASSISTANCE FOR NGRBA

11. The Government of India, through the NGRBA, submits a proposal to the World Bank for an initial investment of approximately US $ 1 billion. The areas where the NGRBA requires cooperation and/or assistance from the World Bank include:

- Creation of sewerage infrastructure in pollution hotspots and other important towns along the Ganga;
- Industrial pollution control, such as setting up of common effluent treatment plants, action plans for industrial hotspots, etc ;

- Strengthening of State Pollution Control Boards for better compliance and enforcement;
- Water conservation in the agriculture sector, industrial sector, and municipalities in order to increase flows. Efforts will include reuse and recycle of treated water and rainwater harvesting;
- Developing decentralised treatment systems;
- Promotion of energy efficiency;
- Revamping of Water Quality Monitoring Programme;
- Support for river front development;
- Implementation of solid waste management system (for both Industrial and Municipal sectors);
- Capacity building for the NGRBA executives;
- Promotion of relevant research and development.

1.5 PURPOSE OF THE ESMF

12. The purpose of the Environmental and Social Management Frame Work (ESMF) is to facilitate the management of environmental and social issues of all investment projects proposed by the NGRBA. The ESMF currently only addresses the broader portfolio of projects to be implemented under the NGRBA, as relevant information for specific projects (i.e. their size, type and location) are either not yet available or are currently being prepared. As specific project identification will operate as a demand-driven process, a single ESMF common to the NGRBA, the SGRBAs and all other project implementing agencies is required.

13. Through their use of an ESMF, the SGRBAs and NGRBA will incorporate international best practices for managing social & environment issues of sub-projects using an explicit management framework.

1.6 COMPOSITION OF THE ESMF

The ESMF has been divided into two volumes

Volume I Environmental and Social Analysis

Volume II Environmental and Social Management Framework

Volume I is titled **Environmental and Social Analysis** and comprises the following sections:

- Project Description
- Ganga Basin Profile
- Ganga Basin - Pollution Aspects

- Initiatives of GOI

Volume II is titled **Environmental and Social Management Framework** and comprises the following sections:

- Project Description
- Environmental Impacts
- Social Impacts
- Environmental and Social Regulatory Framework
- Environmental Management Framework
- Social Management Framework
- Project Appraisal, Monitoring and Reporting Arrangements
- Institutional Arrangements
- Training and Capacity Building
- Budgetary Support.
- Updation / maintenance of the ESMF

SECTION 2
GANGA BASIN PROFILE

2.1 THE GANGA RIVER

14. India is drained by 14 major river systems with a catchment area of nearly 3,250,000 square kilometers. These river systems are grouped into four broad categories: the Himalayan rivers, the Peninsular rivers, the Coastal rivers and the Inland rivers. In addition to the Ganga, the Himalayan river system includes the Indus and Brahmaputra river basins.

15. The Ganga river (with a length of 2525 km) is fed by runoff from the Ganga basin, a vast land area bounded by the snow peaks of the Himalaya in the north and the Peninsular highlands and the Vindhya range in the south. The basin encompasses an area of more than a million square kilometers (1,060,000 km^2) spread over four countries: India, Nepal, Bangladesh and China. With 861,404 square kilometers within India itself, the Ganga basin is the largest river basin in India, that covers 25.22 per cent of India's total geographical area. The catchment area and yield of the river basins in India is given in **Table 2.1**.

Table 2.1 - Catchment Area and Annual Yield of Water in the River Basins of India

S. No.	Basins	Basin Area (SqKm)	Per Cent	Annual Yield of Water (Million cum)	Per Cent	Rate of Flow (cum / sqkm)	Major / Important Tributaries	Major / Important Irrigation Projects
1	Ganga	861404*	26.20	468700	25.22	442170	Yamuna, Ramganga, Gomati, Ghaghara, Gandak, Kosi, Son, Mahananda, Damodar, Rupnarayan	Tehri, Ramganga, Nanak Sagar, Sarda Barrage, Ghaghara Barrage, Kosi, Gandak, Mayurakshi, Panchet, Maithon, Durgapur, Tilaiya, Konar, Farakka, Kangsabati, Bansagar, Rajghat, Chambal
2	Indus	321289*	9.77	79500	4.28	247441	Jhelum, Chenab, Ravi, Beas, Sutlej, Shyok, Dras, Gilgit, Shisar, Zaskar and Swat	Bhakra-Nangal, Thein, Ranbir
3	Godavari	312812	9.51	118000	6.35	377223	Wainganga, Wardha, Penganga, Pranhita, Maner, Manjira, Sabari, Indravati	Pochampad, Wainganga, Siddheswar, Kamthi, Khairy, Jayakwadi, Nizam Sagar
4	Krishna	258948	7.88	62800	3.38	243403	Koyna, Musi, Panch-Ganga, Ghataprabha, Bhima, Malaprabha, Tungabhadra, Masi	Tungabhadra, Bhima, Koyna, Krishna, Bhadra, Nagarjuna Sagar, Hidkal, Vani Vilasa, Sagar, Upper Krishna
5	Brahmaputra	258008*	7.85	627000	33.74	1081034	Tista, Torsa, Jaldhaka, Manas, Kameng, Subansiri, Dibang, Lohit, Burhidihong, Dhansiri	Tista
6	Mahanadi	141589	4.31	66640	3.59	470658	Hasdo, Tel, Ib, Seonath	Hirakud
7	Narmada	98795	3.00	54600	2.94	552660	Goi, Kundi, Tawa, Barna, Orsang	Narmada Sagar, Sardar Sarovar Tawa
8	Cauvery	87900	2.67	20950	1.13	237770	Kabbani, Hemavati, Amaravati, Shimsha, Bhavani	Mettur, Lower Bhabai, Krishnaraj Sagar, Kattalai
9	Tapi	65145	1.98	17982	0.97	276307	Panjhra, Purna, Girna	Kakrapar, Ukai
10	Penner	55213	1.68	3238	0.17	58646	Kunderu, Cheyyeru, Rapagni, Chitravati	-
11	Brahmani	39033	1.19	18310	0.99	202701	South Koel	Rengali
12	Mahi	34841	1.06	11800	0.64	338681	Anas	Mahi
13	Sabarmati	21895	0.67	3800	0.20	173556	Hatmati, Meshwa	Sabarmati
14	Subarnarekha	19296	0.59	7940	0.43	411484	Kharkai	Subarnarekha
15	Medium and Minor Rivers	711833	21.65	296840	15.98	417008	-	-
	Total (India)	**3287782**	**100.0**	**1858100**	**100.0**	**565153**		

Source: Central Pollution Control Board, New Delhi
* Indicate basin area within Indian territory

The Ganga flows through ten states: Uttar Pradesh, Uttarakhand, Bihar, Jharkhand, Delhi, Haryana, Himachal Pradesh, Madhya Pradesh, Rajasthan and West Bengal. The extent of the Ganga basin within these states is given in **Table 2.2** and **Exhibits 1 & 2**.

Table 2.2 - Statewise Share of the Ganga Basin Area

S. No.	State	Total Geographical Area (SqKm)	Per Cent of Total Geographical Area
1	Uttar Pradesh & Uttarakhand	294364	34.2
2	Madhya Pradesh	198962	23.1
3	Bihar & Jharkhand	143961	16.7
4	Rajasthan	112490	13.1
5	West Bengal	71485	8.3
6	Haryana	34341	4.0
7	Himachal Pradesh	4317	0.5
8	Delhi	1484	0.2
	Ganga Basin (Total)	**861404**	**100.0**

Source: National River Conservation Directorate (MoEF), Central Water Commission

2.2 DEMOGRAPHY OF GANGA BASIN

16. The state of the river Ganga is significantly affected by the population living within the basin. The Ganga Basin has 1949 cities and towns, with an estimated population of 125 million. Average population density in the Ganga basin is 520 persons per square km as compared to 312 for India (2001 census). The major cities of Delhi, Kolkata, Kanpur, Lucknow, Patna, Agra, Meerut, Varanasi and Allahabad are situated in the basin. The cities in the basin have large, growing populations and a rapidly expanding industrial base. The state-wise population of Class I and Class II cities is given, along with additional demographic, economic and cultural details, in **Appendices 11a&b**. It was observed that between 1991 and 2001, the urban population increased by 41 per cent If this trend continues, then the pollution load is expected to increase concurrently. District-level demographic information for the section of each state which falls in the Ganga basin is presented hereunder.

2.2.1 BIHAR

16a. In Bihar, there are 12 districts which fall within the Ganga basin namely, Begusarai, , Buxar, Katihar, Khagaria, Lakhisarai, Munger, Patna, Purnia, Saran, Sheikhpura, and Vaishali with a population of about 25,543,106. Some of the main towns which fall in the Bihar region of the basin are Patna, Begusarai, Bhagalpur, Chapra, Munger, Katihar, Hajipur and so on with a

population of about 3539970 which accounts for nearly 14 per cent of the total population in the region. The scheduled tribes account for about 1.4 per cent of the people who inhabit the basin. The demographic details and social profile of the districts falling under the Bihar region of Ganga basin are provided in Appendix 11a.

2.2.1b WEST BENGAL

16b The seven districts of West Bengal which is part of the Ganga basin are 24 Pargana South, 24 Pargana North, Hoogli, Howrah, Kolkota, Maldah, Medinipur. In all, around 42,630,182 people reside in the West Bengal region of the Ganga basin, with about 9,293,861 people residing in major towns like Maheshtala, Rajpur Sonarpur, Serampore, Hugli-Chinsurah, Chandannagar, Haora, Kolkota, Bhatpara, South Dum DUm and so on. Around four per cent of the population in the basin belongs to the scheduled tribe class. The demographic details and social profile of the districts falling under the West Bengal region of Ganga basin are provided in Appendix 11b.

2.2.1c UTTRAKHAND

16c The State of Uttrakhand has three districts which fall in the Ganga basin: Hardwar, Tehri Garhwal and Uttarkashi. These districts have a total population of 2,346,947. Of that total number, only 383,779 reside in some of Uttrakhand's major towns which reside in the Ganga Basin. The largest of these towns are Hardwar (MB), Tehri (MB), Uttarkashi (MB) and Dhaluwala (CT). Only 6,515 scheduled tribal people reside in Uttrakhand's share of the Ganga basin, comprising about .002 per cent of Uttrakhand's Ganga basin population. The demographic details and social profile of the districts falling under the Uttrakhand region of Ganga basin are provided in Appendix 11c.

2.2.1d JHAHRKHAND

16d The State of Jharkhand has only one district, known as Sahibganj, which falls in the Ganga basin. The district of Sahibganj has a population of 927,770. The two major towns of this district are Sahibganj and Rajmahal, which have a combined population of only 98,131. In sharp contrast to most other districts in the Ganga basin, Sahibganj's tribal population of 270,423 greatly exceeds the amount of people living in its major towns and comprises 29 per cent of Jharkhand's Ganga basin population. The demographic details and social profile of the districts falling under the Uttrakhand region of Ganga basin are provided in Appendix 11d.

2.2.1e UTTAR PRADESH

16e The state of Uttar Pradesh (UP) has 17 districts in the Ganga basin, namely: Ballia, Allahabad, Bulandshahar, Azamgarh, Fatehpur, Varanasi,

Farrukhabad, Sant Ravidas Nagar Bhadohi, Saharanpur, Rae Bareli, Mirzapur, Kanpur Nagar, Kanpur Dehat, Kannauj, Jyotiba Phule Nagar, Ghazipur and Bijnor. These districts have an enormous combined population, totaling 45,595,698 in number. Some of the larger towns in UP's share of the Ganga basin include Allahabad (M Corp), Saharanpur (MB), Fatehpur (MB), Varanasi (M Corp), Farrukhabad-cum-Fatehgarh (MB), Kanpur (M Corp) and Mirzapur-cum-Vindhyachal (MB), with the total large town population of UP in the Ganga basin reaching 8,078,852. UP's tribal population in the Ganga basin numbers only 16,621, accounting for an insignificant per cent of the total number. The demographic details and social profile of the districts falling under the Uttrakhand region of Ganga basin are provided in Appendix 11e.

2.2.2 CULTURAL SIGNIFICANCE OF RIVER GANGA

17. The Ganga has been a cradle of human civilization since time immemorial. Millions depend on this great river for physical and spiritual sustenance. People have immense faith in the powers of healing and regeneration of the Ganga. It is considered one of the most sacred river in the world and is deeply revered by the people of India, playing a vital role in religious ceremonies and rituals. To bathe in Ganga is a lifelong ambition of many who congregate in large numbers for several river-centered festivals such as Kumbh Mela and numerous Snan (bath) festivals. People also travel from distant places to immerse the ashes of their kin in the waters of the Ganga, believing that this immersion will send the ashes to heaven. Several places which lie along the banks of the river Ganga are considered sacred for Hindus, including Haridwar, Varanasi, Allahabad and Kashi, and these places attract large numbers of pilgrims and tourists for these reasons. Kumbh Mela alone is considered one of the world's largest congregation of devotees.

2.3 COURSE OF THE GANGA

18. The Ganga rises in the Garhwal Himalaya (30^{o}55'N, 79^{o}7'E) under the name of Bhagirathi. The ice-cave of Gaumukh at the snout of the Gangotri glacier, at 3892 metres above sea level, is recognized as the traditional source of the Ganga. The river cuts through the Himalayas until another head stream, the Alaknanda, joins at Devapraya. It is below this confluence that the united stream of Bhagirathi and Alaknanda is known as the River Ganga.

19. After running some 250 kilometres from its source, the Ganga pierces through the Himalayas at Sukhi (near Rishikesh), before turning southwestwards for another 30 km or so where it finally descends into the vast Indo-Gangetic

plain at Haridwar (elevation 283m). At this point, the river swells into a mighty stream of 750 metres wide. At Rishikesh, the Ganga delivers an average of 27 billion cubic metres of crystal clear water per annum. Throughout the course of the Ganga, from its source at Gaumukh to its mouth at Sagar Island in Bay of Bengal, it is a common practice for Indians to take daily dips in the holy waters of the Ganga, especially at places of pilgrimage like Rishikesh, Haridwar, Garhmuktesar, Kannauj, Allahabad, Mirzapur and Varanasi.

20. Besides bathing, the Ganga water is widely used for domestic and industrial purposes in towns and villages located on its course. The other major use of Ganga water is for irrigation. For example, the Upper Gangetic Canal network, located near Hardiwar, siphons off large quantities of water for irrigating a major portion of the Ganga-Yamuna plains in Uttar Pradesh, reducing flow in this area to only 15 billion cum per annum at Balawali. Further downstream, a few minor tributaries join adding to the rate of water in Ganga. At Garhmuktesar, minor streams join the Ganga to increase the flow to 22 billion cum in a year. The annual flow continues to rise for some 240 km downstream of Haridwar until Narora is reached, and the annual flow rises further, where another large irrigation network, the Lower Gangetic Canal, once again greatly reduces river flow. Located near Narora, the Canal system takes off at a barrage spanning the 1164-metre river bed., leaving again a much reduced flow in downstream of River Ganga.

21. The Ganga does not receive any major tributary until the Ramganga joins at Kannauj, adding some 15.26 billion cum of water annually. At Allahabad (1020 km from the source), the Ganga is joined on the right by the River Yamuna, which actually contributes more water (76 billion cum / annum or 58.5 per cent of total flow) than the main river itself, augmenting the flow volume of the Ganga to a level of 130 billion cubic metres per year.

22. Further downstream, with the aid of the Yamuna, the volume of water flow in the Ganga rapidly rises, reaching a level of 240.5 billion cum per annum at Patna, despite the large scale upstream withdrawal of water for irrigation.

23. After Allahabad, the Ganga begins to receive several major tributaries at more frequent intervals, namely, the Tons, Son, Gomati, Ghaghara, Gandak, Burhi Gandak and Kosi. The Ganga eventually reaches the head of its delta at Farakka, beyond Rajmahal, in Jharkhand, having increased its flow volume with each tributary. In addition to flow volume, water quality and sediment load also fluctuate depending on the composition of the contributing stream.

24. Below Farakka, the Ganga bifurcates into the Padma and the original channel of the Ganga, known as the Bhagirathi. Therefore, the Bhagirathi is treated as the main Ganga for all purposes in West Bengal. The Padma, carrying the major share of water of the Ganga, eventually flows southeastwards into Bangladesh, while the Bhagirathi (Ganga) winds southwards down the deltaic plain of West Bengal before emptying into the Bay of Bengal under the name of Hugli. Nearly halfway between Farakka and Sagar Island, the hydraulic character of the Bhagirathi (Ganga) suddenly changes upon its entry into the tidal zone of the Gangetic delta. The speed and direction of water in the estuarine streams and creeks are in continual flux due to the ebb and flow of the tides.

25. The tributaries which contribute the largest amount of water per annum are,: the Ghaghara river (94.4 billion cum), followed by the Yamuna (76 billion cum), the Kosi (61.56 billion cum), the Gandak (52.5 billion cum), the Son (22.42 billion cum), the Ramganga (15.26 billion cum), the Damodar (12.21 billion cum), the Gomati (7.39 billion cum), the Burhi Gandak (7.1 billion cum) and the Tons (4.93 billion cum). The contributions made by the different tributaries of Ganga are given in **Table 2.3**. The Ganga attains a flow volume of 240.5 billion cubic metres per year at Patna and rises further to 320.4 billion cum at Azamabad in Bihar. The boundaries of the sub-basins of the major tributaries of River Ganga are shown in **Exhibit 1 & 2**.

Table 2.3 - Catchment Area, Annual Yield of Major Tributaries in Ganga Basin

S. No.	Stream / Tributaries	Area of Basin		Total Annual Yield		Rate of Flow	
		SqKm	Per Cent	Million Cum	Per Cent	Cum / s	Cum / SqKm
1	Yamuna	366223	4.2	76000	16.2	2410	207524
2	Son	71259	8.3	22420	4.8	711	314627
3	Ghaghara	57578*	6.7	94400	20.1	2993	740392
4	Ramganga	32493	3.8	15258	3.3	484	469578
5	Gomati	30437	3.5	7390	1.6	234	242797
6	Damodar	25820	3.0	12210	2.6	387	472889
7	Tons	16860	2.0	4927	1.0	156	292230
8	Kiul	16580	1.9	5900	1.3	187	355850
9	Karmnasa and Adjoining Streams	11709	1.4	5750	1.2	182	491075
10	Kosi	11000*	1.3	61560	13.1	1952	708400
11	Haldi	10210	1.2	5300	1.1	168	519099
12	Burhi Gandak	10150	1.2	7100	1.5	225	699507
13	Dwarka	8850	1.0	4687	1.0	149	529604
14	Rupnarayan	8530	1.0	4400	0.9	140	515826
15	Punpun	8530	1.0	3577	0.8	114	419343
16	Gandak	7620*	0.9	52200	11.1	1655	1139738
17	Ajay	6050	0.7	3207	0.7	102	530083
18	Other Streams	170035	19.7	31400	6.7	996	184668
19	**Ganga (Total)**	**861404***	**100.0**	**468700**	**100.0**	**14862**	**442170**

* Area figures relate to the part of basin falling within Indian Territory only
Sources: Rao (1975) and Central Water Commission

2.4 STREAM AND FLOW CHARACTERISTICS OF GANGA

26. Due to a high gradient and a tremendous velocity, Himalayan rivers including the Ganga have a strong erosive power. The geological fact that the Himalayan rivers run through poorly consolidated sedimentary rocks affected by folds and faults results in high rates of erosion and silt deposition. Landslide debris further add to the silt load.

27. The high intensity of rainfall in the Himalayan region means that more than 60 percent of the water flowing into the Ganga basin comes from the Himalayan streams joining the Ganga from the north. The Peninsular streams combine to contribute only 40 percent of the water, despite the fact that the catchment area of the Peninsular streams extends well over 60 percent of the entire Ganga basin.

28. The weather in the Ganga basin is characterized by a distinct wet season, with more than 70 percent of the region's total annual rainfall coming during the period of the southwest monsoon (June to September). A dry spell during the summer (March to May) and a short winter (December to February) complete the region's seasonal patterns. The streams within the Ganga basin have significant variation in flow pattern during the wet and dry seasons.

29. Excluding the five major tributaries (Yamuna, Ghaghara, Kosi, Son and Gandak), all other tributaries of the Ganga have a rather poor annual rate of water flow, ranging from as low as 100 to 500 cubic metres per second (Ref. **Table 2.3**). As a result of these low flows, these tributaries, along with the minor ones, are very susceptible to water pollution, especially during the dry season.

As described above, the main river's flow rate fluctuates reach to reach, and its susceptibility to pollution varies accordingly. The annual water flow in the River Ganga at 90-per centile level, as measured at different reaches, is given in **Table 2.4**.

Table 2.4 Annual Flow and Rate of Flow of Water in the Ganga at 90-percentile Level						
S. No.	**Station**	**Distance from Source (Km)**	**Elevation from Mean Sea Level (m)**	**Period of Observation**	**Annual 90-Percentile flow (Million cum)**	**Ninety Percentile rate of Flow (cum / second)**
1	Rishikesh	250	350	1971-1981	14241	452
2	Balawali	330	280	1976-1981	8413	267
3	Garhmuktesar	440	200	1967-1981	12322	391
4	Kachla Bridge	510	160	1972-1981	8605	273
5	Fatehgarh	670	145	1972-1981	6777	215
6	Kanpur	800	138	1960-1981	14446	458
7	Allahabad	1050	95	1970-1981	37291	1182
8	Mirzapur	1170	90	1976-1981	38080	1208
9	Varanasi	1295	80	1960-1981	37976	1204
10	Buxar	1430	60	1960-1981	45651	1448
11	Patna	1600	50	1965-1981	92788	2942
12	Azamabad	2000	35	1960-1981	146643	4650
13	Baharampur	2175	19	1975-1981	25383	805
14	Nabadwip (Purbasthali)	2285	12	1975-1981	30930	981

Source : Central Water Commission

30. It can be seen that upstream of Allahabad (at Kanpur), the 90-per centile rate of flow falls off to a dangerously low 458 cum per second. Water flow in the Ganga basin fluctuates enormously not only due to the seasonal variation of rainfall, but also due to the large scale withdrawal of water for canal irrigation. The annual extraction of water from the Ganga basin for irrigation exceeds 100 billion cubic metres. The major irrigation canals emanating from the Ganga and its tributaries are shown on **Exhibit 2.**

31. The seasonal variation of stream flows at a few selected stations on the Ganga, Yamuna, Son and Tons are given in **Table 2.5**. The monthly stream flow in Ganga at 90, 50 and 10 per centile levels are given in **Appendix 1**.

Table 2.5 Seasonal Variation of Stream Flow in the Ganga Basin						
S. No.	River Station	Mean Seasonal Flow (Million Cum)				Mean Annual Rate of Flow (cum / second)
		Monsoon (Jun-Sep)	Post Monsoon (Oct-Nov)	Winter (Dec-Feb)	Summer (Mar-May)	
A	**Ganga**					
1	Rishikesh (1971-81)	21631	1912	1305	2150	856
2	Balawali (1976-81)	13306	947	167	760	481
3	Garhmuktesar (1967-81)	18392	1756	908	982	699
4	Fatehgarh (1972-81)	17300	1266	264	281	606
5	Kanpur (1960-81)	30763	4139	1518	910	1184
6	Allahabad (1970-81)	112278	10703	4148	2987	4126
7	Mirzapur (1976-81)	97142	9362	4529	3362	3627
8	Varanasi (1960-81)	112206	11244	4213	2793	4105
9	Buxar (1960-81)	113247	17741	5463	3438	4436
10	Patna (1965-81)	192625	28488	11044	8341	7626
11	Azamabad (1960-81)	235357	54494	18055	12474	10159
12	Baharampur (1975-81)	12817	6055	8140	6277	1056
13	Nabadwip (Purbasthali) (1975-81)	18666	7763	7910	7107	1314
B	**Yamuna**					
1	Tajewala	6800	1400	900	1400	333
2	Delhi Rly. Bridge	6500	800	200	400	251
3	Etawah	7300	1000	300	200	279
4	Pratappur	61600	9300	3400	1700	2410
C	**Son**					
1	Chopan (1960-81)	14867	2105	1915	1534	648
2	Koelwar (1960-81)	17699	2256	1497	966	711
D	**Tons**					
1	Maje Rd. (1960-81)	4159	491	194	83	156

Source : Central Water Commission, MoEF

32. From **Table 2.5**, it can be observed that upstream from Fatehgarh, the minimum flow occurs in winter (December to February), while lowest flow in the rest of the course of the Ganga is in the summer (March to May). The Yamuna also has its lowest flows in the winters in the area upstream of Delhi, while the area downstream of Delhi sees its minimum in the summer. In the Peninsular tributaries, like the Son and Ton, the lowest flow occurs in the summer season. Overall, the flow of water in all the streams of the Ganga basin reaches critically low levels during the long, dry season from December to May - a serious concern which must be factored into any pollution control and prevention management programme administered in the basin.

33. Based on stream characteristics, the entire 2,525 km course of the Ganga can be conveniently divided into the following major five sections: (i) mountainous, (ii) upper plain, (iii) middle plain, (iv) deltaic non-tidal and (v) deltaic tidal plain. The stream characteristics of the river Ganga, from its source to its outfall in the Bay of Bengal, are given in **Table 2.6**.

Table 2.6 Stream Characteristics along Different Sections of the Ganga					
S. No.	**Stretch**	**Section**	**Length (Km)**	**Average Slope of Land**	**Mean Annual Rate of Flow (cum / second)**
1	Source to Rishikesh	Mountainous	250	1 in 67	850
2	Rishikesh to Allahabad	Upper plain	770	1 in 4,100	850 - 1,700
3	Allahabad to Farakka	Middle plain	1005	I in 13,800	4,000 -10,200
4	Farakka to Nabadwip	Deltaic non-tidal plain	230	1 in 23,000	1,000 - 1,300
5	Nabadwip to outfall	Deltaic tidal plain	240	1 in 24,000	Variable due to the tides
Source : Central Water Commission					

34. The mountainous section stretches from the river's source to Rishikesh, with an average bed slope of one in 67 and a mean flow rate of 850 cubic metres per second at Rishikesh. The subsequent upper plain section extends from Rishikesh downstream and until Allahabad at a slope of one in 4,100 and a mean flow rate ranging between 850 and 1,720 cum per second before its confluence with the Yamuna. The third, middle plain section stretches from Allahabad to Farakka, with a slope of one in 13,800 and an increase in the mean flow rate to 10,200 cum per second at Azamabad. Following this part lies the upper deltaic non-tidal plain section, with a slope of one in 23,000 and a much reduced mean flow rate of 1,300 cum per second near Nabadwip. The final segment is the lower deltaic tidal plain section, with a slope of one in 24,000 and varying flows due to influence of the tides.

35. The fairly large volume and high flow of the Ganga in the middle plain section (1,005 km) between Allahabad and Farakka render this stretch relatively less vulnerable to pollution, compared to the sections on the upstream of Allahabad and downstream of Farakka. For instance, the mean annual flow at the rate of 7,626 cum per second at Patna, between Allahabad and Farakka, is high enough to wash off significant amounts of pollutants. However, above Allahabad the mean annual flow is less than 1,700 cum per second and, as a result, the upper plain course of the Ganga is liable to be polluted to some extent if adequate precautionary measures are not taken; this fact is especially true during the lean months. This same increased susceptibility to pollution also occurs downstream of Farakka, where the mean annual stream flow again falls off drastically to a level of 1,300 cum per second at Nabadwip. Further down, especially in the estuarine section near the outfall, the up-and-down movement of the water periodically causes temporary suspension of the water current, as the tide shifts from ebb to flow tide and vise versa. As a result of this stagnation, removal of pollutants in the tidal section can expected to be slow and difficult.

36. The flow of water in various streams of the Ganga basin varies enormously from year to year, season to season, month to month and even day to day.

Accordingly, it is extremely essential to consider the extreme low stage conditions of water flow in the streams in each month - instead of only the average scenarios - when planning pollution monitoring and mitigation programs. In the flow data given in **Appendix 1**, the monthwise 90, 50 and 10-per centile stream flow values of a few stations on the Ganga during the flood stage in the months of July, August and September are several times higher than the rates in the lean flow period during the dry months. In Rishikesh, for example, the leanest month is February, with a mean rate of flow of 155 cum/s, while August has the highest mean rate of flow of 3,159 cum/s. However, the corresponding 90-per centile values are much less, 138 cum/s and 2,146 cum/s respectively. Some 80 km downstream, at Balawali, the lowest flow occurs in January (19 cum/s) and the highest in August (1,955 cum/s), while the corresponding 90-per centile values are only 5 cum/s and 1,316 cum/s respectively. The water flow here is greatly reduced and the stream characteristics undergo a dramatic change on account of the large scale water withdrawal by the Upper Gangetic Canal.

37. Further downstream at Patna, despite a significant volume of water, the monthly flow characteristics show certain peculiarities. At this location, April is the leanest month with a mean rate of flow of 997 cum/s, while flood reaches its high water mark in September with a mean rate of flow of 33,823 cum/s. However, the 90-per centile values shows the lowest flow (540 cum/s) in February and the 10-per centile value shows the highest flow (37,424 cum/s) in August. In order to incorporate the necessary safety margins into the design of pollution control measures, the 90-per centile monthly values of the stream flows (as given in **Appendix 1**) should be considered more dependable than the corresponding mean values. At some stations, the 90-per centile values are sometimes nearly half of the mean values if not lower – a serious concern from the standpoint of pollution abatement in the river Ganga.

As evidenced by the above data, extreme low stage flow conditions must be considered while planning any discharges.

2.45 PHYSIOGRAPHY OF GANGA BASIN

38. Physiographically, India is divided into seven major sections: (1) Northern Mountains, (2) Great Plains (3) Central Highlands (4) Peninsular Plateaus, (5) East Coast, (6) West Coast and (7) Islands.

39. The Ganga basin falls entirely within the first three divisions. The peninsular plateau of the Gangetic trough (with an elevation of less than 300 metres) is filled with older (Pleistocene) and recent alluvia, forming nearly 4,000,000 SqKm in the states of Haryana, Rajasthan, Uttar Pradesh and West Bengal , comprising 50% of basin area. The Ganga basin can be divided into the following eight physiographic divisions, briefly described below and shown in **Exhibit 2**.

2.5.1 Trans-Yamuna Plain

40. This sector constitutes the western end of the Ganga basin, covering the states of Haryana and Rajasthan. The region is characterized by thick, unconsolidated material subtly sloping down from the western watershed towards the Yamuna. On account of the flat topography, water logging and saline efflorescence has been recorded in many areas, especially since the introduction of large-scale and intensive irrigation practices through the Western Yamuna Canal.

2.5.2 Ganga-Yamuna Doab

41. East of Trans-Yamuna plain lies the Ganga-Yamuna interfluvial doab tract, which stands out as a large slab of older alluvial (bangar) terrace sloping towards the south and southeast, falling off from a level of 283 metres at Haridwar to some 95 metres at Allahabad. The twin rivers, Ganga and Yamuna, wind along the low-lying (khadar) flood-plain belts built up by the younger alluvial sediments deposited during periodical inundations. The bangar terraces, on the contrary, are thick deposits of older silts, rising high above the khadar plain – up to 20 metres at times - measured from the present river beds. The bangar surface of the Ganga-Yamuna doab has a rather variegated topography interspersed by breaks of slope due to terrace formations and sand belts (bhur), which stand out like transverse sand dunes.

2.5.3 Rohilkhand

42. To the east of the Ganga-Yamuna doab lies the large plain land of Rohilkhand, which extends from the Ganga to near Lucknow, where the land steps down on to the lower alluvial plain of Avadh. Rohilkhand comprises a flight of several river terraces separated from each other by step-like breaks of slope. The highest terrace is located at the Himalayan foothills and is built up of bouldery bhabar deposits.

2.5.4 Avadh Plain

43. Further east of Rohilkhand and lying at a lower elevation is the Avadh plain. The Avadh plain comprises the extensive khadar belts of several mighty streams, the chief of which is the Ghaghara.

2.5.5 North Bihar Plain

44. Further east, the great riparian plain of North Bihar appears. The North Bihar plain is riddled with numerous old river beds which have been deserted by the Kosi in the course of its movement from the eastern end of Bihar to its present position as the main channel in the west. For this reason, the North Bihar plain is characterized by numerous linear depressions left by the Kosi during its shift from east to west. Besides these depressions, there are also large marshes and waterlogged areas, known as the chorus, along the Ganga.

2.5.6 North Bengal Plain

45. At the farthest end of the Ganga basin is the North Bengal plain, which contains Pleistocene deposits of the Barind region, terraces of coarse grained materials and tarai depressions in the piedmont plain below the Darjeeling hills.

2.5.7 Bengal Basin

46. South of the Ganga (Padma), lies the Bengal basin, which comprises much ofthe Gangetic delta plain's recent alluvium and its western rim. The western rim is made up of Pleistocene alluvial formation (often lateritic), as the land slopes up towards the rocky Chota Nagpur plateau.

2.6 SOIL CHARACTERISTICS

47. The Ganga basin is characterized by a wide variety of soils. The soils of the high Himalayas in the north are subject to continued erosion and the Gangetic trough provides a huge receptacle into which thousands of metres of thick sediment layers are deposited to form a wide valley plain. The plateau on the south has a mantle of residual soils of varying thickness arising due to the weathering of the ancient rocks of the peninsular shield. Ten classes of soils have developed in the Ganga basin under different lithological, climatic and pedogenetic conditions.

48. Some of the soils within the Ganga basin are highly susceptible to erosion. Such soils need adequate conservation measures and appropriate land management interventions, with an eye towards preserving the soil resource and keeping the turbidity levels of the surface water within tolerable limits. The susceptibility of each of the soil groups to erosion and the areas covered in

the different States within the Ganga basin are indicated in **Table 2.7**. The soil classification map of Ganga basin is given in **Exhibit 3**.

Table 2.7 - Soils Types in Ganga Basin and Their Susceptibility to Erosion (Area in Square Kilometres)

S. No.	State	Mountain Soils	Submon-tane Soils	Alluvial Soils	Red Soils	Red & Yellow Soils	Mixed Red & Black Soils	Deep Black Soils	Medium Black Soils	Shallow Black Soils	Laterite and Lateritic Soils	Total Area
1	Haryana	–	–	33516	684	–	–	–	–	–	–	**34200**
2	Uttar Pradesh & Uttarakhand	12428	32586	209491	16457	740	4438	10502	3621	3962	188	**294413**
3	Bihar & Jharkhand	–	–	91881	32338	19333	–	–	–	–	858	**144410**
4	West Bengal	–	–	57323	704	7271	–	–	–	–	6712	**72010**
5	Rajasthan	–	–	40768	12166	16827	9810	9332	9394	9085	–	**107382**
6	Madhya Pradesh	–	–	17272	39075	5990	11168	14251	79881	33470	598	**201705**
7	Himachal Pradesh	1296	4280	223	–	–	–	–	–	–	–	**5799**
8	Delhi	–	–	1225	260	–	–	–	–	–	–	**1485**
	Ganga Basin	**13724**	**36866**	**451699**	**101684**	**50161**	**25416**	**34085**	**92896**	**46517**	**8356**	**861404**
	Per cent of Total Area	**1.59**	**4.28**	**52.44**	**11.80**	**5.83**	**2.95**	**3.96**	**10.78**	**5.40**	**0.97**	**100**
	Susceptibility to Erosion	**Very High**	**Very High**	**Very High**	**High**	**Moderate**	**Moderate**	**Low**	**Low**	**Low**	**Low**	–

Source: Central Pollution Control Board, National River Conservation Directorate (MoEF).

49. Among the soil types within Ganga basin, the alluvial soil covers more than 52 per cent of the basin (**Table 2.7**). The alluvial deposits of the basin not only cover the great Gangetic trough, but also extend over a sizable portion of the peninsular foreland in the form of a layer less than 3 metres thick. The entire alluvial formation is endowed with rich soil nutrients. The alluvial deposits of the Ganga and its tributaries, coming down the Himalaya and the peninsular foreland, have been yielding annual harvests of crops for the past thousands of years without much serious deterioration. Besides paddy, this tract produces a wide variety of crops including wheat, jowar, bajra, small millets, pulses of different kinds, maize, cotton, jute and many other food and commercial crops.

50. If managed properly, the alluvial soils are highly fertile soils, capable of producing the highest possible yields of crops to feed the millions. However, these soils are sensitive to change and prone to rapid degradation and pollution. In certain parts of the basin, the soils are already showing signs of salinity (as in Haryana), alkalinity (as in western U.P.), calcareousness (as in north Bihar) and acidity (as in West Bengal) due to overuse, long occupation and continued application of inputs like excessive irrigation water and toxic agro-chemicals of various types. The land degradation status within Ganga basin is given in subsequent sections.

2.7 CLIMATIC FACTORS

51. The Ganga basin forms an extensive bowl of warm air, especially during the day-time. The mean maximum daily temperature even in the coldest month (January) does not fall below 21°C, except in the higher hills, whereas the air temperature starts rapidly rising all over Ganga basin from March onwards,

beginning a hot season that prevails from April to June. Usually, May is the hottest month in most part of the basin, except in lower Bengal.

In the Gangetic plains, westwards of Gaya, the daily mean maximum temperature in May rises to 40°C and above. During May, the mean daily maximum air temperature shoots up as high as 42.6°C in Kota in the Central Indian upland region. The air temperature in other areas are; Allahabad (42.1°C), Agra (41.8°C), Hissar (41.6°), Gaya (41.3°C), Lucknow (41.2°C and Bareilly (40.5°C). The high summer heat causes the air to expand and to move upwards, carrying a lot of suspended pollutants into the upper atmosphere. Under this high temperature regime, much of the pollutants become suspended in the air and are held aloft for a considerable period of time in the atmosphere. Some of the pollutants are brought down by rain drops where they eventually find their way into surface runoff systems.

52. Throughout the Ganga basin, the cold weather period extends from December to February. January is the coldest month, with the temperature often falling below 10°C; this is especially true in the valley plain west of Gaya, where the daily mean minimum air temperature in January reaches 10.1°C. In January, the daily mean minimum temperature plummets as low as 5.5°C in Hissar, followed by Dehra Dun (6.1°C), Delhi (7.3°C), Agra (7.4°C), Gonda (8.3°C), Bareilly (8.6°C), Lucknow (8.9°C) and Allahabad (9.1°C). In the lower Gangetic plain the minimum temperature is usually higher: 11.0°C in Patna, 12.2°C in Asansol and 12.3°C in Kolkata. Low temperatures are often associated with the intrusion of cold air from across the Gangetic plain in the months of December and January. In the cold of the winter months, the heavy cold layers of the atmosphere act as blankets upon the land surface, not allowing the suspended pollutants in the air to escape into the higher atmosphere.

2.7.1 Temperature

53. Daily mean maximum and mean minimum air temperatures, mean monthly rainfall and the mean monthly evaporation, as recorded at selected stations in the Ganga basin, are given in **Exhibit 3** and **Appendix 2**.

2.7.2 Rainfall

54. The weather in the Ganga basin is characterized by a distinct wet season during the period of south west monsoon (June to September). The air temperature in the Ganga basin starts falling with the onset of the monsoon from June onwards, making the weather more humid and equable. The diurnal range between the daily mean minimum and the daily mean maximum

temperature becomes lower and lower as the monsoon advances. Eventually, the lowest diurnal range of temperature occurs at the peak of the monsoon, which is usually in August, though sometimes in July. The diurnal range of temperature during this time can be as low as 5.5°C at Patna to 9.4°C at Hissar. As soon as the monsoon is over, the diurnal range of temperature starts increasing rapidly to a maximum attained during the month of November at a large number of places, such as Lucknow (20.2°C), Hissar (19.8°C), Agra (17.2°C) and Delhi (16.9°C). In certain places the highest diurnal range occurs before the onset of the monsoon - generally in either March or April - as in Gonda (16.8°C), Allahabad (16.3°C), Gaya (16.3°C), Asansol (14.6°C), or Patna (14.3°C).

55. Due to its proximity to the coast, Kolkata stands as an exception, with its highest diurnal range (14.1°C) occuring during the coldest month (January). On account of high population density and a heavy concentration of industrial units in the Kolkata Metropolitan District, the effect of this temperature is very pronounced, with frequent episodes of smog in the winter evenings followed by mist in the colder morning hours.

56. The southwest monsoon makes landfall at the mouth of the Ganga around the first week of June and advances upstream. By the end of July the monsoon reaches the western end of the Ganga basin. In the majority of the basin, the rainy season spreads over three months (July, August and September) and usually 70 to 85 per cent of the total annual rainfall occurs during this period. In the eastern part of the basin (as in West Bengal and Bihar), the wet season is longer, usually starting in June and continuing until the end of September or early October.

57. The geographical distribution of the mean annual rainfall in the basin is shown by isohyetal lines on **Exhibit 3**. The isohyetal lines indicate that the lowest precipitation in the Gangetic plain occurs in Haryana (less than 400 mm per annum), with the rainfall increasing downstream until reaching lower Bengal, where nearly 1,600 mm of rainfall occurs. Heavier rainfall continues in the upper Himalayan region, such as in Dehra Dun, where the rainfall is as high as 2,313 millimeters per annum.

58. The geographical distribution of the mean annual rainfall in the basin is shown by isohyetal lines on **Exhibit 3**. The isohyetal lines indicate that the upper Himalayan receives heavier rainfall of 2313 mm per year, contributing sufficient runoff to the basin. In the downsream Ganga basin, rainfall levels decrease to an average value of 1000mm, with Haryana receiving the least

precipitation (400mm per annum). Due to this limited rainfall, the lower part of the Ganga basin is more dependent on glacial melt upstream, making it more vulnerable to varying climatic conditions; as a result, the area is subject to frequent flooding and drought situations.

2.7.3 Evaporation

59. Due to the high temperature conditions which prevail over the Ganga basin for the greater part of the year, a significant quantum of water is lost through evaporation. In fact, except in lower Bengal and the Himalaya, the total annual evaporation is far greater than the total annual rainfall received. This fact indicates that the greater part of the basin would be hydrologically dry if the total annual rainfall were distributed evenly over the twelve months of the year. Since the vast majority is concentrated in a three month span in most of the basin, the water available from rainfall usually exceeds what is lost through evaporation during this period, allowing some surplus water to flow down the Ganga river and its tributaries. The rainfall and evaporation rates as recorded at selected stations in Ganga basin is given in **Table 2.8.**

Table 2.8 Rainfall and Evaporation at Selected Stations in the Ganga Basin

S. No.	Station	Mean annual rainfall (mm) 1951-1980	Mean annual evaporation (mm) 1959-1975	Difference between annual rainfall and annual evaporation (mm)	Water surplus in wet months: Jul-Sep (mm)	July to September rainfall expressed as percentage of annual rainfall
1	Dehra Dun	2315.4	1289.2	+ 1025.5	1774.3	76.6
2	Delhi (Safdarjang)	797.3	2223.8	– 1409.1	618.0	77.5
3	Hissar	490.6	2579.1	– 2189.2	352.6	71.9
4	Agra	776.5	2232.2	– 1450.6	624.8	80.5
5	Allahabad	1017.7	1843.6	– 816.3	797.5	78.4
6	Gaya	1075.0	2220.1	– 1122.8	802.1	74.6
7	Patna	1003.4	1886.1	– 776.5	807.1	80.4
8	Kota	843.4	2591.4	– 1749.9	687.4	81.5
9	Calcutta (Alipore)	1641.4	1401.9	+ 173.2	956.5	58.3
10	Bareilly	1071.9	1908.7	– 840.4	782.7	73.0

Source: India Meteorological Department

60. Within the Ganga basin, every square kilometre of land surface area receives an average of one million cubic metres of water annually through rainfall, which is about 861 billion cum. Less than half of this total is actually available, after accounting for water lost through evapo-transpiration (30 percent) and seepage into the ground (20 percent). The gross numbers for evaporation and seepage into the groundwater have been estimated at around 293.8 billion cubic metres and 212.8 billion cubic metres, respectively. Thus, the total annual surface flow of water in the Ganga basin is estimated to be around 468 billion cubic metres of water.

2.8 GROUNDWATER RESOURCES

61. The Ganga basin, by virtue of its alluvial makeup, is endowed with vast resources of ground-water. The yield rates of groundwater and major aquifer systems occurring within the basin are given in **Exhibit 2 & 4**. It can be seen that, except for some isolated patches, the greater part of the extensive Gangetic plain (lying mainly on the north of the Ganga in Uttar Pradesh and Bihar) yields groundwater at a rate of more than 150 cum per hour. The lower part of the Ganga Yamuna doab in Uttar Pradesh and the Bhagirathi-Hugli basin in West Bengal have an equally high yield of groundwater.

62. Aquifer zones of moderate yield [between 50 cum and 150 cum per hour] occur in several areas such as the upper Ganga-Yamuna doab (Uttar Pradesh), the plains of Alwar and Jhunjhunun (Rajasthan), the Ganga-Ghaghara doab in Uttar Pradesh, the Magadh plain (Bihar) and the Rarh plain (West Bengal).

63. Aquifers of still lower yield (less than 50 cum/hour) are scattered over different parts of the Ganga basin, including the outer Himalayan range, the Jaipur-Bharatpur tract (Rajasthan), the lower Chambal valley (Madhya Pradesh), the Bundelkhand upland (Uttar Pradesh), the south Bihar plains, the Baghelkhand plateau (Madhya Pradesh) and the Rarh highlands (West Bengal).

64. In the remaining part of the Ganga basin, available aquifers with yield less than 20 cum/hour are scattered in local pockets (areas are shown as unhatched on **Exhibit 2**). A special zone, yielding water under artesian conditions at a high rate of more than 150 cum per hour, is marked by crossed-hatchings along the Himalayan foothills.

65. The other special zones, yielding saline water at varying rates, are indicated by a pattern of dots on **Exhibit 2**. These aquifers are found (often in patches) in the Trans-Yamuna region of Haryana, Rajasthan and Uttar Pradesh and also in the lower Ganga-Yamuna doab. The aquifers in the coastal areas of West Bengal as shown on the figure yield brackish water at a rate of more than 150 cum per hour.

2.9 GROUNDWATER POTENTIAL AND USE

66. The Ganga basin has a vast reservoir of groundwater, replenished every year at a very high rate. The conjunctive use of groundwater for irrigation, even within the canal command areas, not only ensures steady supply to the

cultivated fields on time but also helps reduce water logging and salinization due to consequent downward movement of subsurface moisture.

67. The vast Gangetic alluvial trough is characterized by not only one of the most prolific aquifers, in quantitative terms, but also by the relatively high quality of the available, although the quality deteriorates as one proceeds down the river to the outfall. Along the Himalayan foothills (bhabar and tarai belts), the water is of high quality, as these belts are under continuous recharge from the Himalayan streams. In certain localized areas of the Ganga plain, the fluoride content in the groundwater is high enough to cause dental decay when consumed for a long time. In certain areas adjoining the tarai belt the groundwater iodide content is low, often causing iodine deficiency in human body. In the central alluvial trough, the groundwater has low mineral contents, but near the southern fringe of the alluvial formation, especially in certain parts of Agra, Aligarh, Mathura, Mainpuri and Ballia districts of Uttar Pradesh, the mineral content increases. Near the delta area in West Bengal, the water in certain aquifers turns saline due to incursion of sea water. Otherwise, on the whole, the groundwater in the Gangetic alluvial formation is of sufficiently good quality for use in irrigation.

68. The groundwater usage for irrigation in the states of the Ganga basin exceeded 104.7 billion Cum per year (as of 1996) and accounted for nearly 50 per cent of the groundwater irrigated area of the entire country. The net annual groundwater availability for irrigation, domestic and industrial usage in the states of the Ganga basin has been assessed at 187.42 billion Cum per year. Some 60 per cent of this potential has already been utilized. The groundwater usage pattern in these states is given in **Table 2.9,** as well as data showing the extent of groundwater utilization for irrigation, which is around 47 BCM per year in Uttar Pradesh and Uttarakhand, 16 BCM per year in Madhya Pradesh and 11 BCM per year in West Bengal.

Table 2.9 Groundwater Usage Pattern in the states falling under Ganga basin					
S. No.	State	Annual Groundwater Draft (BCM per year)			Net annual Groundwater availability
		Irrigation	Domestic and Industrial uses	Total	
1	Haryana	9.1	0.35	9.45	8.63
2	Uttar Pradesh & Uttarakhand	46.7	3.47	50.17	72.28
3	Bihar & Jharkhand	10.09	1.75	11.86	32.67
4	West Bengal	10.84	0.81	11.65	27.46
5	Rajasthan	11.6	1.39	12.99	10.38
6	Madhya Pradesh	16.08	1.04	17.12	35.33
7	Himachal Pradesh	0.09	0.02	0.12	0.39
8	Delhi	0.2	0.28	0.48	0.28
	Total	**104.7**	**9.11**	**113.84**	**187.42**
	India	**212.51**		**230.62**	**399.25**
Source: Central Groundwater Board, 1996					

69. Apart from irrigation, groundwater resources are also being heavily tapped for industrial and domestic uses majoring both urban and rural areas. Throughout the alluvial area of the Ganga basin, the major urban water supply schemes are dependant upon groundwater resources. Similarly, a large number of industries also withdraw significant amounts of groundwater, especially from the easily accessible aquifers in the alluvial zone.

70. The mean annual replenishable groundwater in India as a whole has been assessed at 488 billion cumec per year, of which about 230 billion cumec per year (53%) lies in the states of the Ganga basin. The annual replenishable groundwater levels, annual groundwater draft and balance of groundwater available for further exploitation for each state within the Ganga basin is given in **Table 2.10**.

Table 2.10 Groundwater Recharge Potential and Withdrawal (Net Draft) per annum					
S. No.	**State**	**Annual Replenishable Groundwater (BCM per Year)**	**Annual Groundwater Draft (BCM per Year)**	**Balance available (BCM per year)**	**Stage of Groundwater Development**
1	Haryana	9.31	9.45	-0.14	109
2	Uttar Pradesh	76.35	48.78	27.57	70
3	Uttarakhand	2.27	1.39	0.88	66
4	Bihar	29.19	10.77	18.42	39
5	Jharkhand	5.58	1.09	4.49	21
6	West Bengal	30.36	11.65	18.71	42
7	Rajasthan	11.56	12.99	-1.43	125
8	Madhya Pradesh	37.19	17.12	20.07	48
9	Himachal Pradesh	0.43	0.12	0.31	30
10	Delhi	0.3	0.48	-0.18	170
	Total	**202.54**	**113.84**		
	India	**433.02**	**230.62**		
Source: Central Groundwater Board, 1996					

71. Among the various states within the Ganga basin, Uttar Pradesh has the largest replenishable groundwater potential, with 76.35 billion cumec per year of the usable groundwater; of this total, about 48.78 billlion cumec per year is currently in use primarily for irrigation, although a large share is consumed in the major cities for domestic and industrial purposes. Madhya Pradesh has the second highest replenishable potential in the basin at around 37.19 billion cum per annum here. The stage of groundwater development is highest in Haryana, with 109 per cent, followed by Uttar Pradesh, Uttarkhand, West Bengal and Bihar.

2.10 LAND USE

72. The Ganga basin is extensively cultivated over an estimated 509,994 sqkm of land, constituting 62.4 per cent of the total area of the basin. About 14.3 per cent of land (189,646 sqkm) is not available for cultivation and put to various non-agricultural uses. Although the net sown area constitutes 52.4 per cent of the basin area, the ratio of the gross sown tract to the net sown area turns out to be 130 per cent, which indicates that a substantial portion of the net sown area is under double cropping. In some isolated areas of intensive farming, a small per centage of land is also put to triple cropping and inter-culture of several crops together. The landuse pattern and intensity of landuse within the Ganga basin is given in **Table 2.11**.

Table 2.11 Land Use Pattern and Intensity in states falling under Ganga Basin (1976 - 77)
(Area in Square Kilometres)

S. No.	State	Total Area	Total Reporting Area	Non-Arable Area	Habitation Area	Forest Area	Cultivable Area	Net Sown Area	Gross Sown Area	Economic Use**
1	Haryana	34200	21265	3844 (18.08)	761 (3.58)	516 (2.43)	16905 (79.49)	12749 (59.95)	22981	65.96
2	Uttar Pradesh & Uttarakhand	294413	294413	45733 (15.53)	17388 (5.91)	43238 (14.69)	205442 (69.78)	173541 (58.94)	231782	79.54
3	Bihar & Jharkhand	144410	138296	40003 (28.93)	13408 (9.70)	10438 (7.55)	87855 (63.52)	68950 (49.86)	95892	67.11
4	West Bengal	72010	50717	7656 (15.09)	5452 (10.75)	3833 (7.56)	39228 (77.35)	33342 (65.74)	45832	84.05
5	Rajasthan	107382	102883	41995 (40.82)	2288 (2.22)	8955 (8.70)	51933 (49.78)	46227 (44.93)	56009	55.85
6	Madhya Pradesh	201705	201705	48203 (23.90)	3612 (1.79)	46536 (23.07)	106966 (53.03)	91671 (45.45)	101652	70.31
7	Himachal Pradesh	5799	5799	1454 (25.07)	89 (1.54)	3443 (59.37)	902 (15.55)	821 (14.16)	1340	75.07
8	Delhi	1485	1485	758 (51.04)	650 (43.78)	14 (0.94)	713 (48.01)	690 (46.46)	1000	91.18
	Ganga Basin	**861404**	**816563**	**189646 (23.22)**	**43648 (5.35)**	**116973 (14.33)**	**509944 (62.45)**	**427991 (52.41)**	**556488**	**72.09**
	India		**3287782**	**740400 (22.51)**	**114784 (3.49)**	**672000 (20.44)**	**1574000 (47.87)**	**1402000 (42.64)**	**1673000**	**66.57**

* Figures in parenthesis indicate intensity in % of total geographical area.
** In terms of % of total geographical area.

Source: Central Board for the Prevention and Control of Water Pollution

73. Non-arable land in the Ganga basin covers a considerable area of 189,646 square kilometres which constitute some 23.2 per cent area of the basin. This category of land comprises such tracts, which cannot be put to agricultural or silvicultural uses at an economic level due to their unproductive nature, as well all lands put to various economic uses other than non-agricultural or non-forest activities, such as mineral exploitation or construction of human settlements, industrial structures, roads, railways, airports and other civil works needed for providing transport, communication and similar infrastructural facilities for human habitation.

74. A large proportion of the non-arable land is used in urbanization and in construction of homesteads in rural areas all over the thickly populated basin of the Ganga. Over 5.3 per cent of the total geographical area of the basin is used for construction of human habitations alone (**Table 2.11**).

75. The Ganga basin has only 14.3 per cent of the area under forest cover, as compared to India as a whole at 20.4 per cent of land under forest cover. The extent of state forests (reserved, protected and unclassed) has been shown in **Exhibit 5**. In some States, especially Haryana, Bihar, Jharkhand, West Bengal and Rajasthan, the forest cover is as low as 2.4 to 8.7 per cent of the geographical area. Most of forest tracts within the Ganga basin are severely degraded on account of over exploitation. As a result, the forest ecosystem in the Ganga basin is under severe stress. Even in the better forested states of

Himachal Pradesh (59.4 per cent), Madhya Pradesh (23.1 per cent) and Uttar Pradesh (14.7 per cent), the proportion of land actually under dense tree cover within the government forest tracts is very low due to extensive clear felling of trees carried out in recent decades.

76. The Ganga basin is very extensively cultivated. The intensity of cultivation is indicated more clearly by the total or gross sown area in relation to the net sown area (**Table 2.11**). The gross sown area in the Ganga basin turns out to be 130 per cent of the net sown area, which means that a large part of the net sown area is double cropped or possibly even triple cropped. Some 62.5 per cent of the total land surface of the basin is cultivable as compared to country level of 47.9%. The proportion of cultivable land is much higher in the more fertile alluvial plains of the Ganga than the basin average, rising to some 79.5 per cent in Haryana and 77.4 per cent in West Bengal. In Uttar Pradesh, the cultivable land is nearly 69.7 per cent. On the contrary, in the uplands of Madhya Pradesh and the semi-arid tracts of Rajasthan, the proportion of cultivable area falls off to 53 and 49.8 per cent respectively.

77. Cultivable land includes the area actually sown (or net sown), the culturable wastes and fallow lands. These culturable wastes and fallows together constitute as much as 10 per cent of the basin. The net sown area thus covers around 52.4 per cent of the land surface in the Ganga basin as against 42.6 per cent in India taken as a whole. The highest per centage of the net sown area is in West Bengal (65.7%) followed by Haryana (60%) and Uttar Pradesh (59%), whereas in Bihar and Jharkhand the per centage of the net sown area falls off to 50%. The net sown area in Rajasthan and Madhya Pradesh drops further to around 45 per cent. The distribution of cultivable area in Ganga basin is given in **Table 2.12**.

Table 2.12 Distribution of Cultivable Area in the states falling under Ganga Basin							
S. No.	**State**	**Gross sown to cultivable area (per cent)**	**Gross sown to net sown area (per cent)**	**Net sown to cultivable area (per cent)**	**Net irrigated to net sown area (per cent)**	**Average number of crops grown**	**Rural population per Sqkm of cultivable land**
1	Haryana	135.94	180.26	75.42	53.60	1.80	195.00
2	Uttar Pradesh & Uttarakhand	112.82	133.56	84.47	47.80	1.34	410.00
3	Bihar & Jharkhand	109.15	139.07	78.48	40.20	1.39	713.00
4	West Bengal	116.83	137.46	85.00	38.80	1.37	602.00
5	Rajasthan	117.84	121.16	89.01	28.10	1.21	200.00
6	Madhya Pradesh	95.03	110.89	85.70	10.10	1.11	151.00
7	Himachal Pradesh	148.56	163.22	91.02	16.20	1.63	441.00
8	Delhi	140.25	144.93	96.77	76.80	1.45	787.00
	Ganga Basin	**109.13**	**130.02**	**83.93**	**35.80**	**1.30**	**398.00**
	India	**106.29**	**119.33**	**89.07**	**25.10**	**1.19**	**327.00**
Source: Central Board for the Prevention and Control of Water Pollution							

2.11 NATURAL VEGETATION – GANGA BASIN

78. The type of vegetation depends on edaphic, climatic and biotic factors, among which the effect of the climatic factor is most significant. The main climatic factors which control vegetative activity are temperature, sunlight and precipitation. In India, four temperature zones are distinguishable as given in **Table 2.13**. Among these, the tropical and subtropical temperature zones are most predominant in the entire Ganga basin. The climatic diversities results into a number of vegetation zones.

Table 2.13 Temperature Zones of India				
S. No.	**Zone**	**Mean Annual Temp (^oC)**	**Mean Temp Jan. (^oC)**	**Remarks**
1	Tropical	Over 24	Over 18	No frost
2	Sub-Tropical	17 to 24	10 to 18	Frost is rare
3	Temperate	7 to 17	-1 to 10	Frost, some snow
4	Alpine	Under 7	Under -1	Snow
Source: Environmental Atlas of India, CPCB				

79. India's major vegetation zones can be classified into 16 major types, spread over some 64 million hectares, out of which six are tropical, three are sub-tropical, three are temperate and one each of alpine, littoral and swamp types. The major vegetation types of India are given in **Table 2.14**. The natural vegetation that prevails in Ganga basin is given in **Exhibit 6**.

Table 2.14 Different Groups of Forest in India		
S. No.	**Forest Group**	**%**
1	Tropical Wet Evergreen	8.75
2	Tropical Semi-Evergreen	3.35
3	Tropical Moist Deciduous	33.92
4	Littoral and Swamp	0.38
5	Tropical Dry Deciduous	30.16
6	Tropical Thorn	5.11
7	Tropical Dry Evergreen	0.29
8	Sub-Tropical Broad-Leaved	0.38
9	Sub-Tropical Pine	5.99
10	Sub-Tropical Dry Evergreen	0.36
11	Montane Wet Temperate	3.45
12	Himalayan Moist Temperate	3.79
13	Himalayan Dry Temperate	0.28
14	Sub-Alpine and Alpine	3.79
	Total	**100.0**
Source: Forest Survey of India		

80. Out of the 16 vegetation types, the most abundant group type is tropical moist and dry deciduous, which together account for over 70% of country's forest area, followed by tropical thorn forest (6.9%), tropical wet evergreen (6%) and sub-tropical pine forests (5%).

The vegetation type of the Ganga basin is largely comprised of tropical moist and dry deciduous types. The vegetation type of Ganga basin are described below.

2.11.1 Tropical Moist Deciduous Vegetation

81. This vegetation type thrives in areas having moderate rainfall of 1500-2000mm, a mean annual temperature of 26^{o}C to 27^{o}C and an average relative humidity of 60 to 80 per cent. It is also known as the monsoon forest as the trees shed their leaves during dry season. It is found on the Western Ghats, eastern coastal plain, eastern plateau, Himalayan foothills and in some parts of Sutlej-Ganga plains. Common trees are *sal,* teak, sandal wood, *arjun, jarul, ebony mulberry, kusum siris, palas, mahua, simul* and *dhup*.

2.11.2 Tropical Dry Deciduous Vegetation

82. The dry deciduous vegetation type grow in areas where rainfall is less than 150mm and dry period is relatively long. Trees grow shorter than tropical moist deciduous category and the undergrowth is shrubby and grassy. During the hot dry phase (March to May months), the trees shed their leaves. It is found in eastern Rajasthan, Kathiawar, rainshadow area of the Deccan

plateau, central India and Punjab. Common plants are teak, *sal, bijasal, laurel, palas, khair* and *kendu*.

2.11.3 Sub-Tropical Coniferous Vegetation

83. It is a pure association of chir pine without underwood and a few shrubs. It is found throughout the whole length of the northwest Himalaya between elevation of 1000-1800m.

2.11.4 Himalayan Dry Temperature Vegetation

84. It is found in the inner dry ranges of the Western Himalaya where precipitation is below 1000mm, and is predominantly a coniferous forest with xerophytic shrubs. Epiphytes and climbers are rare. Important species are *chilgoza, deodar, oak, maple, ash, celtis, parrotia, olive*, etc.

2.11.5 Himalayan Moist Temperate Vegetation

85. In the western Himalaya, between 1500m and 3000m elevation, forests of deodar, spruce, maple, walnut, poplar, cedar, chestnut, birch, oak etc. occur. These are 30 to 50m high. Undergrowth is mostly evergreen. Mosses and ferns grow freely on trees.

The extent of forest cover among the various states within Ganga basin is given in **Table 2.15**.

Table 2.15 Extent of Dense Forest, Open Forest and Mangrove (in Sq.Km) of the states coming under Ganga Basin, as of 1997

S. No.	State / UT Forest	Dense Forest	Open Forest	Mangrove Forest	Total	Per Capita (ha)
1	Bihar & Jharkhand	13300	13224	–	**26524**	0.03
2	Delhi	16	10	–	**26**	–
3	Haryana	370	234	–	**604**	–
4	Himachal Pradesh	9560	2961	–	**12521**	0.24
5	Madhya Pradesh	82745	48450	–	**131195**	0.20
6	Rajasthan	3690	9663	–	**13353**	0.03
7	Uttar Pradesh & Uttarakhand	22958	11036	–	**33994**	0.02
8	West Bengal	3557	2669	2123	**8349**	0.01
	Ganga Basin	**136196**	**88247**	**2123**	**226566**	**0.53**
	India as a Whole	**367260**	**261310**	**4827**	**633397**	**0.07**

Source: Environmental Atlas of India, CPCB and MoEF

2.12 ENVIRONMENTALLY SENSITIVE AREAS

86. The Environmentally sensitive areas comprise Biosphere Reserves, Wildlife Sanctuaries, National Parks and Tiger Reserves among others. The environmentally sensitive areas within the Ganga basin are briefly summarized hereunder.

2.12.1 Biosphere Reserves

87. The Government of India has established 15 Biosphere Reserves of India, (categories roughly correspond to IUCN Category V protected areas), which protect larger areas of natural habitat (more than a National Park or Animal Sanctuary) and often include one or more National and / or preserves, along buffer zones that are open to some economic uses. Protection is granted not only to the flora and fauna of the protected region, but also to the human communities which inhabit these regions and their ways of life. The list of Biosphere reserves in India is given in **Appendix 3.**

88. The Ganga basin has two Biosphere reserves, namely the Nanda Devi Biosphere and the Sundarbans National Park, which are also a part of the World Network of Biosphere reserves (**refer Table 2.16**). The location of Biosphere reserves within Ganga basin are shown in **Exhibit 7**.

Table 2.16 Biosphere Reserves coming under Ganga Basin

S. No.	Year	Name	Location	State	Type	Area (SqKm)
1	1989	Sunderbans*	Part of Delta of Ganges and Barahamaputra River System	West Bengal	Gangetic Delta	9630
2	1988	Nanda Devi*	Parts of Chamoli District, Pithoragarh District and Almora District	Uttarakhand	West Himalayas	5860.69

Souce: MoEF

* Also a part of World Network of Biosphere Reserves, based on the UNESCO main & Biosphere (MAB) programme list

2.12.2 National Parks

89. A National Park is a reserve of natural or semi-natural land, declared or owned by the Government of India, set aside for human recreation and enjoyment, animal and environmental protection and restricted from most development. The International Union for Conservation of Nature (IUCN) and its World Commission on Protected Areas has defined National Parks as its Category II type of protected areas.

90. At present India has 94 National Parks, spread all across the country, out of which 32 National Parks are within the Ganga basin and their locations are shown in **Exhibit 7**. Out of 32 National Parks, 9 National parks given in **Table 2.17** are located in the project area in the Ganga Basin..

Table 2.17 National Parks located near the Study area (Ganga Basin)					
S. No.	**Year**	**Name**	**Location**	**State**	**Area (SqKm)**
1	1989	Valmiki National Park	West Champaran	Bihar	335.65
2	1977	Dudhwa National Park	–	Uttar Pradesh	490.29
3	1988	Nanda Devi Biosphere Reserve	Chamoli, Almora and Pithoragarh District	Uttarakhand	5860.69
4	1989	Gangotri National Park	Gangotri	Uttarakhand	1552.73
5	1983	Rajaji National Park	Haridwar	Uttarakhand	820.42
6	1936	Corbett National Park	Kumaon and Lower Garhwal	Uttarakhand	520.82
7	1990	Govind Pashu Vihar	Uttarkashi	Uttarakhand	472.08
8	1982	Valley of Flowers National Park	Rishikesh	Uttarakhand	87.50
9	1984	Sundarbans National Park	Sundarbans	West Bengal	1330.10

Source: Central Pollution Control Board, Forest Department of Bihar, Uttar Pradesh, Uttarakhand and West Bengal

2.12.3 Wildlife Sanctuaries

91. India has 551 animal sanctuaries, commonly referred to as Wildlife Sanctuaries (IUCN Category IV protected area). Wildlife sanctuaries of national importance to conservation, usually due to some flagship faunal species are named as National Wildlife Sanctuary.

92. Out of this 551, 134 are located in the Ganga basin, spread across Bihar, Jharkhand, Delhi, Haryana, Himachal Pradesh, Madhya Pradesh, Rajasthan, Uttarakhand, Uttar Pradesh and West Bengal. The summary of the statewise list of wildlife sanctuaries within Ganga basin is given in **Table 2.18** and locations are shown in **Exhibit 7**. The detailed list of wildlife sanctuaries in the entire Ganga basin are given in **Appendix 4**.

Table 2.18 Wildlife Sanctuaries in the states falling under Ganga Basin				
S. No.	**Year**	**State / UT**	**No. of Wild Life Sancturies**	**Area (SqKm)**
1	1976-1985	Bihar	12 Locations	3514.95
2	ND	Delhi	1 Location	13.2
3	1975-1987	Haryana	2 Locations	124.89
4	1949-1985	Himachal Pradesh	28 Locations	3565.48
5	1976-1985	Jharkhand	4 Locations	1324.42
6	1972-1983	Madhya Pradesh & Chattisgarh	31 Locations	10240.42
7	1955-1985	Rajasthan	22 Locations	5118.34
8	1954-1987	Uttar Pradesh	15 Locations	3302.42
9	1972-1988	Uttarakhand	2 Locations	1020.83
10	1976-1990	West Bengal	17 Locations	1040.85
		Total	**134 Locations**	
Source: Central Pollution Control Board				

2.12.4 Tiger Reserves

93. Among the 551 wildlife sanctuaries across India, 28 have special significance for the conservation of the tiger and therefore designated as Tiger Reserves and governed by **Project Tiger**. The **Project Tiger** - is a wildlife conservation program initiated in India in 1972 to protect the Bengal Tigers. The project aims at tiger conservation in specially constituted tiger reserves representative of various regions throughout India. It strives to maintain a viable population of this conservation reliant species in their natural environment.

94. Out of the 28 designated tiger reserves, 4 are located near the project area in the Ganga Basin. The list of tiger reserves in Ganga basin are given in **Table 2.19** and locations of all the tiger reserves located in entire Ganga Basin are shown in **Exhibit 7**.

Table 2.19 Tiger Reserves located near the Study area (Ganga Basin)

S. No.	Year	Name	State	Area (SqKm)
1	1989	Valmiki	Bihar	880.78
2	1973	Corbett	Uttarakhand	821.99
3	1987	Dudhwa	Uttar Pradesh	884.00
4	1973	Sunderbans	West Bengal	2585.00

Source:National Tiger Conservation Authority (MoEF)

2.12.5 Mangrove Forests

95. Among the states within Ganga basin, only West Bengal has the mangrove forests in Sunderbans area.

2.13 IRRIGATION

96. The Gangetic plain is one of the most extensively irrigated basin in the world. The net irrigated area within the basin is some 153 million square kilometres (as of 1976-77), which constituted more than 43.6 per cent of the net irrigated area of India taken as a whole. In many of the basin, the fields are repeatedly irrigated for raising crops more than once within a year. Thus, considering all such multiple irrigated areas together, the gross irrigated area within the basin is estimated to be of the order of 188 million square kilometres. The intensity of irrigation within the Ganga basin is given in **Table 2.20**.

Table 2.20 Intensity of Irrigation in the Ganga Basin (2001-2002)							
S.No.	**State**	**Net area irrigated from all sources (sqkm)**	**Net Canal Irrigated (SqKm)**	**Gross area irrigated from all the sources (SqKm)**	**Net irrigated to net sown (percent)**	**Canal irrigated/net irrigated (percent)**	**Gross irriagetd to gross sown area**
1	Haryana	29380	14760	53110	82%	50%	84%
2	Uttar Pradesh & Uttarakhand	123910	30910	177130	74%	25%	69%
3	Bihar & Jharkhand	47770	18140	59880	39%	38%	38%
4	West Bengal	23760	2610	36610	43%	11%	37%
5	Rajasthan	54200	13540	67440	32%	25%	32%
6	Madhya Pradesh	47350	8080	48990	32%	17%	26%
7	Himachal Pradesh	1020	30	1810	19%	3%	19%
8	Delhi	290	2	390	100%	7%	75%
	Ganga Basin	327680	88072	445360	47%	27%	45%
	India as a whole	558770	159890	764430	40%	29%	40%
Source: Central Water Comission							

97. As per the data compiled by National Commission on Agriculture (1976), each year some 85 billion (thousand million) cubic metres of surface water is used in the basin, mainly for irrigation. In addition, 49.4 billion cubic metres are drawn from groundwater resources, underground reservoir annually (**Table 2.21**). There is a net irrigated area of 153,324 square kilometres in the Ganga basin. A large proportion of the water used eventually goes as recharge into the subsoil layers through the cultivated fields. The entire quantity of water used comes from the net balance amount of the rain water received every year after deduction on account of the loss by evaporation and transpiration. The total annual rainfall in the entire Ganga basin is of the order of 1000 billion cubic metres. After a loss of about 318.5 billion cubic metres due to evapo-transpiration, there is a net estimated balance of 681.5 billion cubic metres of water. This eventually exits the land surface as run off and/or seeps down into the subsoil as groundwater recharge, a portion of which again often oozes out at lower levels into streams. A substantial amount, however, is also pumped out for use in irrigation or other activities. In the Ganga basin, nearly 212.8 billion cubic metres of water go into the ground as annual gross recharge, leaving 468.7 billion cubic metres for flowing on the surface (**Table 2.21**). In course of movement of water, either overland or below the surface, various chemical compounds get dissolved in such water. Some of such extraneous chemical constituents are derived from the residues of pesticides and chemical fertilizers, which are added to the soil every year for better yield of crops.

Table 2.21 Surface Water and Groundwater Resources in the Ganga Basin (1979-80)						
S. No.	**State**	**Surface Water Flow (million cum)**	**Groundwater recharge (million cum)**	**Total Reserve (million cum)**	**Per Cent of Total Basin Reserve**	**Reserve Per Unit Area (cum / sqkm)**
		Gross Annual Reserve				
1	Haryana	8100	6507	14607	2.14	427105
2	Uttar Pradesh & Uttarakhand	189100	101750	290850	42.68	987898
3	Bihar & Jharkhand	144100	23887	167987	24.65	1163264
4	West Bengal	55100	10748	65848	9.66	914066
5	Rajasthan	10500	35574	46074	6.76	429066
6	Madhya Pradesh	56200	33850	90050	13.21	446444
7	Himachal Pradesh	5250	107	5357	0.79	923780
8	Delhi	350	383	733	0.11	493603
	Ganga Basin	**468700**	**212806**	**681506**	**100**	**791161**
	India	**1858100**	**471010**	**2320110**	**–**	**708383**
		Utilizable Annual Reserve				
	Ganga Basin	**185000**	**148965**	**333965**	**49.00**	**387700**
	India	**666000**	**329707**	**995707**	**–**	**302851**
		Net Annual Withdrawal				
	Ganga Basin	**85000**	**49434**	**134434**	**19.73**	**156065**
	India	**250000**	**125359**	**375359**	**–**	**114168**
Sources: Irrigation Commission (1972), Rao (1975), Pathak (1982), Central Water Commission. N.B. The estimates are provisional.						

98. The surface and groundwater resources in the Ganga basin given in **Table 2.21**, which shows that the various states within the basin are endowed with rich water resources, both surface and underground. The total annual gross reserve of water comes to 681.5 billion cubic metres, as against the Indian total of 2329.1 billion cubic metres. About 42.7 per cent of the gross basin reserve is located in Uttar Pradesh alone. In fact, three Gangetic States – Uttar Pradesh, Bihar and West Bengal – have between them 77 per cent of the basin total. Incidence of water reserve is the highest in Bihar, 1.2 million cubic metres to every square kilometre of land surface. However, the entire quantity of the gross annual accumulated reserve is not extractable for use. In the Ganga basin, some 41 per cent of the gross reserve, i.e. 334 billion cubic metres of water, is available for use, which constitute 33% of the available Indian total reserve. So far, only some 20 per cent of the gross reserve, that is 134.4 billion cubic metres of water, has been actually put to various uses annually, mainly irrigation within the basin, which constitutes by some 85 billion cubic metres drawn from surface water sources and 49.4 billion cubic metres drawn from groundwater sources,

99. In the Ganga basin, there are several major systems of canals within the basin, as shown on **Exhibit 2**. The upper Gangetic main canal, taking off from Haridwar, is 230 km long and carries a discharge of about 300 cubic metres per second. Further down, the lower Gangetic canal has a discharge of more than 150 cubic metres per second. These two systems together can irrigate some 14,000 square kilometres of cultivated land. Further to the east, the

Sarda canals, drawing water from the mighty Ghaghara River at the rate of 325 cubic metres per second, are irrigating more than 9,000 square kilometres of land. The total length of canal network now stands at some 9,500 kilometres, to be eventually augmented to a vast network of 13,680 kilometres of canal. The major irrigation projects within Ganga basin are given in **Table 2.22**. A number of dams have come up in the basin to provide water for irrigation, hydro-power development and for flood control. In the Ganga basin, some 33.5 billion cubic metres of water are presently held as live storage in reservoir, with the largest quantity in the Rihand reservoir (Govind Ballabh Pant Sagar), which holds nearly 9 billion cubic metres of water.

Table 2.22 Major Irrigation Projects within Ganga Basin

S. No.	Canal Project	Live Storage (million cum)	Canal Discharge (cum / second)	Gross Area Irrigated (1976-77) (SqKm)
	Haryana			
1	Western Yamuna	—	106	5440
	Uttar Pradesh & Uttarakhand			
2	Upper Ganga	2613	298	7517
3	Lower Ganga	—	157	5920
4	Eastern Yamuna	—	85	2091
5	Agra Canal	—	92	1592
6	Sarda	634	325	9100
7	Matatila	780	N.A.	1638
8	Betwa	84	67	1200
9	Ken	60	57	743
10	Ramganga	1937	141	4400
	Bihar & Jharkhand			
11	Gandak	—	147	7880
12	Kosi	—	N.A.	4330
13	Son	8971	N.A.	3472
14	Tribeni	—	N.A.	733
	West Bengal			
15	Damodar	4226	N.A.	3400
16	Mayurakshi	555	N.A.	2400
17	Kangsabati	972	N.A.	3240
	Rajasthan/ Madhya Pradesh			
18	Chambal	8500	N.A.	4570

Source: Central Water Commission

100. Canals cater to some 28 per cent of the net irrigated area. Besides canals, wells are also important sources of water used in irrigating certain regions, such as in Uttar Pradesh (73%), West Bengal (59%), Madhya Pradesh (64%), Delhi (88%) and Rajasthan (71%), with net irrigated area served by tanks given in paranthesis. The sources of water for irrigation in per centage of net irrigated area within Ganga basin is given in **Table 2.23**. The extent of the canal irrigated and net irrigated area within Ganga basin is given in **Exhibit 8**.

Table 2.23 Sources of Water for Irrigation within Ganga Basin (2000-2001)					
S.No.	**State**	**Canals**	**Tanks**	**Wells**	**Other sources**
1	Haryana	50%	0%	50%	0%
2	Uttar Pradesh & Uttarakhand	24%	1%	73%	2%
3	Bihar & Jharkhand	39%	5%	49%	7%
4	West Bengal	11%	7%	59%	22%
5	Rajasthan	28%	1%	71%	1%
6	Madhya Pradesh	20%	2%	64%	14%
7	Himachal Pradesh	2%	-	11%	86%
8	Delhi	6%	-	88%	6%
	Ganga Basin	28%	2%	65%	6%
	India as a whole	29%	5%	61%	5%
Note: All figures indicate % of net irrigated area					
Source: Central Water Comission					

2.14 FERTILIZER CONSUMPTION

101. Besides irrigation water, fertilizers, insecticides and pesticides are continuously being added to the soils of the Ganga basin. In the Ganga basin, about 10 million tonnes of chemical fertilizers are applied (2007-2008), which represent 45 per cent of India's total annual consumption of 22.5 million tonnes. The consumption pattern of the three different groups of fertilizers and their intensity of application per hectare area of gross sown area within the Ganga basin are given in **Table 2.24**.

Table 2.24 Consumption of Chemical Fertilizers in the Ganga Basin (2007-2008)										
S. No.	**State**	**Consumption of Fertilizers (000' Tonnes)**					**Application of Fertilizers in (Kilograms) per hectare of gross sown area in the year**			
		Nitrogen	**Phosphorus**	**Potassium**	**Total Consumption**	**% of Total Basin Consumption**	**Nitrogen**	**Phosphorus**	**Potassium**	**All Types**
1	Haryana	939.5	257.27	23.59	1220.36	12%	144.4	39.6	3.6	187.6
2	Delhi	0.3	0.08	0.01	0.39	0%	6.8	1.8	0.2	8.9
3	West Bengal	684.54	385.76	304.44	1374.74	13%	71.8	40.5	31.9	144.2
4	Uttar Pradesh & Uttarakhand	2867.38	846.6	192.42	3906.4	38%	200.8	52.2	15.4	268.5
5	Madhya Pradesh	795.69	430.26	75.75	1301.7	13%	40.6	21.9	3.9	66.4
6	Himachal Pradesh	32.34	8.91	8.71	49.96	0%	34.4	9.5	9.3	53.1
7	Rajasthan	705.33	260.46	20.91	986.7	10%	32.5	12	1	45.5
8	Bihar & Jharkhand	1019.04	237.42	94.18	1350.64	13%	167.8	47.6	16	231.3
	Ganga Basin	7044.12	2426.76	720.01	10190.89		87.3875	28.1375	10.1625	125.688
	All India	14,419.12	5514.74	2636.27	22570.13		74.8	28.6	13.7	117.1
Source: The Fertilizer Association of India										

It can be seen from **Table 2.24** that the application of fertilizers is high in the Ganga basin, as against the country level The available data relating to the nutrient level in the Ganga water are not sufficient to draw any definitive conclusions at present.

Although, the consumption pattern in different parts of the basin varies widely, Uttar Pradesh alone consumes 38 per cent of the total fertilizer consumption in the Ganga basin. The absolute distribution of fertilizers, classified according to the contents in terms of nitrogen, phosphorus and potassium, is indicated on **Exhibit 5** by proportional circles for each district in the Ganga basin. The potassium consumption in the Ganga Basin varies greatly from one place to another; for instance, K consumption is 31.9 Kg per hec. in West Bengal, while in Delhi it is only 0.2 Kg per hec. This variation may be generally due to market condition, fertilizer policy and agriculture production practices in the region.

102. The distribution pattern of nitrogen, phosphorus and potassium containing fertilizers within the Ganga basin have represented by red, green and blue coloured circles are shown in **Exhibit 5**. The predominant use of nitrogen based fertilizers, by the spread of larger circles in red all over, especially in the Gangetic alluvial districts can be seen in **Exhibit 5**. The use of phosphorus containing fertilizers, especially in the doab districts between the Ganga and the Yamuna is shown by a string of green circles. The use of potassium containing fertilizers is indicated by blue circles, which is concentrated in the more intensively cultivated tracts within Ganga basin.

103. The estimated nutrient levels in the agricultural wastewater in the Ganga basin are indicated in **Table 2.25**. It can be seen that the nitrogen and phosphorus contents in the wastewater cross much beyond the critical values, supporting undesirable level of algal growth.

Table 2.25 Estimated Nutrient Levels in Agricultural Wastewater in the Ganga Basin (1976-77)

S. No.	State	Nutrients in Wastewater (Tonnes per Annum)			Annual Wastewater Discharge (million cum)	Nutrient Concentration in Wastewater (mg/l)		
		Nitrogen	Phosphorus	Potassium		Nitrogen	Phosphorus	Potassium
1	Haryana	4400	700	400	1741	2.53*	0.40*	0.23
2	Uttar Pradesh & Uttarakhand	55000	10800	5700	14981	3.67*	0.72*	0.38
3	Bihar & Jharkhand	12300	1600	900	4325	2.84*	0.37*	0.21
4	West Bengal	8200	900	1700	2253	3.64*	0.40*	0.75
5	Rajasthan	3400	900	200	2093	1.62*	0.43*	0.10
6	Madhya Pradesh	3800	1700	300	1380	2.75*	1.23*	0.22
7	Himachal Pradesh	100	0	0	27	3.70*	0.00	0.00
8	Delhi	1400	600	0	96	14.58*	6.00*	0.00
	Ganga Basin	**88600**	**17200**	**9200**	**26896**	**3.29***	**0.64***	**0.34**

* Beyond critical value supporting undesirable levels of algal growth

104. It has been estimated that 10 to 15 per cent of the nutrients added to the soils through fertilizers eventually finds their way to the surface water systems. High nutrient level usually stimulates growth of algae in the surface water,

often leading to eutro-phication. Some nutrients like nitrites and ammonia, above certain critical levels of concentration, can be toxic to human use. Some 0.3 mg/l inorganic nitrogen and 0.01 mg/l of inorganic phosphorus in water usually stimulate undesirable algal growth in the surface water. Runoff from arable lands may contain nitrogen up to 70 mg/l and phosphorus ranging from 0.05 to 1.1 mg/l of effluent water. Therefore, the runoff from arable land can raise the nutrient level to a considerable degree in stream waters.

2.15 PESTICIDES APPLICATION

105. The pattern of pesticide application consumption is more or less similar to that of fertilizers, as these two inputs go together in agricultural operation, especially since introduction of the high yielding varieties of crops in recent decades. Some 2.573 tonnes of pesticides of different types are used in the Ganga basin during the year (as of 1976-77).

106. Pesticides of various types are widely used in agricultural operation all over the Ganga basin. However, unlike fertilizers, pesticides are used more sporadically. Consumption of pesticides in the Ganga basin is on the low side and account for only 6 per cent of the total Indian consumption. The pattern of application of pesticides within Ganga basin is given in **Table 2.26**.

Table 2.26 Application of Pesticides in the Ganga Basin (1976-77)

S. No.	State	Consumption of Pesticides (Tonnes) in the year				Application of Pesticides per hectare of net sown are (grams) in the year			
		Organo-chlorine	Organo-Phosphorus	Other Types	Total Consumption	Organo-chlorine	Organo-Phosphorus	Other Types	All Types
1	Haryana	10.5	1.6	15.5	27.6	8.30	1.30	12.20	21.80
2	Uttar Pradesh & Uttarakhand	590.6	30.6	123.3	744.5	34.00	1.80	7.10	42.90
3	Bihar & Jharkhand	73.5	13.7	118.7	205.9	10.70	2.00	17.20	29.90
4	West Bengal	796.3	202.2	352.3	750.8	58.90	60.60	105.70	225.20
5	Rajasthan	285.1	41.8	413.3	740.2	61.70	9.00	89.40	160.10
6	Madhya Pradesh	62.3	2	12.8	77.1	6.90	0.20	1.40	8.40
7	Himachal Pradesh	1.4	0.9	7.8	10.1	17.30	11.10	95.50	123.90
8	Delhi	16	0.4	0.4	16.8	231.90	5.80	5.80	243.50
	Ganga Basin	**1235.7**	**293.2**	**1044.1**	**2573**	**28.90**	**6.80**	**24.40**	**60.10**
	India	**N.A.**	**N.A.**	**N.A.**	**44509**	**–**	**–**	**–**	**317.50**

Source: Central Pollution Control Board

107. A large variety of chemicals are used by the farmers to eradicate various types of agricultural pests, including insects and other organisms. While a sizable number of pesticides have organo-chlorine compounds as the basic ingredients, there is another distinctive group having organo-phosphorus compounds. Apart from these, there are a far greater number of different compounds, which fall in neither of these two broad categories. In the Ganga basin, the largest quantity of pesticides used is of the organo-chlorine type (some 1,236 tonnes annually) followed by organo-phosphorus compounds

(293 tonnes). Other forms of pesticides (1044 tonnes) are also consumed in the basin. Among these, Organo-chlorine pesticides are highly toxic in nature as compared to other forms of pesticides.

108. The highest consumer of organo-chlorine compounds is Uttar Pradesh, accounting for 48 per cent of the basin's total organo-chlorine consumption, followed by West Bengal's at 16 per cent. The consumption of organo-phosphorus compounds is nearly 70% of the total basin consumption in West Bengal. The pattern of consumption of the three groups of pesticides in different states is indicated in **Table 2.26**.

The spatial distribution of the these three groups of pesticides is shown on **Exhibit 8** by coloured proportional circles, green for organo-chlorine, red for organo-phosphorus and blue for the other types.

2.16 LAND DEGRADATION – GANGA BASIN

109. The term land degradation refers to the decline in the productivity and quality of land resulting from natural calamities as well as human actions. The land degradation and associated loss of soil productivity is the subject of environmental concern.

110. Across India, about 175 million Ha (53.3 per cent of the total geographical area) of land are subjected to different kinds of degradation problems, such as water erosion (90m Ha), wind erosion (50m Ha), salinity and sodicity (7m Ha) and flooding (20m Ha). Another 20m Ha of land under canal command is under the risk of becoming degraded.

111. Within the Ganga basin, the land degradation problems mainly comprise water erosion, chemical deterioration due to salinization and physical deterioration due to water logging. Within the Ganga basin, the dominant land degradation problems in each state are different. For instance, the soil erosion is most dominant in Madhya Pradesh, whereas the water logging is most dominant in Bihar, Jharkhand and possibly West Bengal. The salinity problems are dominant in intensely cultivated Uttar Pradesh.

The extent of land degradation problems within Ganga basin is given in **Table 2.27**. The soil degradation problems within the Ganga basin is shown in **Exhibit 9**.

Table 2.27 Extent of Water Logged and Salt Affected Areas in Irrigation Command Areas (1991)						
S. No.	**State**	**Soil Erosion (million ha)**	**Waterlogged Area (million ha)**	**Salt Affected Area (million ha)**	**Land Degradtion Due to Other Causes (million ha)**	**Total Problem Area (million ha)**
1	Bihar & Jharkhand	42.60	0.62	0.22	22.92	**66.36**
2	Haryana	15.91	0.25	0.20	25.71	**42.07**
3	Himachal Pradesh	19.14	0.00	Not reported	–	**19.14**
4	Madhya Pradesh	196.10	0.07	0.04	11.07	**207.28**
5	Rajasthan	167.30	0.18	0.07	174.92	**342.47**
6	Uttar Pradesh & Uttarakhand	71.10	0.43	1.15	60.05	**132.73**
7	West Bengal	10.33	Not reported	Not reported	32.70	**43.03**
	Ganga Basin	**522.48**	**1.55**	**1.68**	**327.37**	**853.07**
	India as a Whole	**1234.48**	**2.46**	**3.30**	**470.20**	**1710.44**
Source: Environmental Atlas of India, CPCB						

2.17 SALINITY AND WATER LOGGING PROBLEMS

112. The annual consumption of irrigation water in the Ganga basin, estimated to some 134.5 billion cubic metres. Out of this, 85 billion cubic metres are drawn from the surface sources and 49.5 billion cubic metres from the underground reservoirs. At an average rate of 200 milligrams of salts per litre of surface water, the total quantity of salts annually added to the soils in the Ganga basin works out to be some 17 million tonnes. Similarly, groundwater contributes another 24.7 million tonnes of salts in a year at an average rate of 500 milligrams per litre. Thus, the total quantity of salts comes to 41.7 million tonnes. If this amount of salt were to be distributed over the total annual flow of the Ganga (468.7 billion cum), the salinity level in the Ganga would rise to of 88.5 milligrams per litre. Since irrigation is practiced all across in the Ganga basin, the salts carried by the irrigation water get more or less uniformly distributed over the entire irrigation command area measuring about 153,324 Sqkm. The amount of salt added every year is estimated to be some 272 tonnes to a square kilometre of irrigated tract in the Ganga basin. The state-wise distribution of irrigation water supply and the total quantity of salts annually added due to irrigation within Ganga basin are given in **Tables 2.28 and 2.29** respectively.

Table 2.28 Irrigation Water and its Salt Load in the Ganga Basin								
S. No.	State	Irrigation Water (Million cum per Annum)			Salt Load in Irrigation Water (Million Kilograms per Annum)			Salt Concentration in Irrigation Water (Milligrams per Litre)
		Surface Water	Ground Water	Total Supply	In Surface Water	In Ground Water	Total Salt	
1	Haryana	4371	4335	8706	874	2168	3042	349
2	Uttar Pradesh & Uttarakhand	44551	30456	74907	8911	15178	24089	322
3	Bihar & Jharkhand	15601	6024	21625	3120	3012	6132	384
4	West Bengal	8521	2746	11267	1704	1373	3077	273
5	Rajasthan	7010	3455	10465	1402	1728	3130	299
6	Madhya Pradesh	4607	2291	6898	921	1145	2066	300
7	Himachal Pradesh	95	40	135	19	20	39	289
8	Delhi	244	237	481	49	118	167	347
	Ganga Basin	**85000**	**49484**	**134484**	**17000**	**24742**	**41742**	**310**
Source: Central Pollution Control Board								

Table 2.29 Annual Salt Accretion in Irrigated Area and Generation of Wastewater from Irrigated Fields in the Ganga Basin							
S. No.	State	Net Area Irrigated (SqKm)	Annual Salt Accretion in Irrigated Area (Tonnes)		Annual Generation of Wastewater Discharge from Irrigated Fields (cum)		Salt Load in Wastewater (Tonnes per Year)
			For Entire Area	Per SqKm	For Entire Area	Per SqKm	
1	Haryana	6839	3042000	444	1741000000	254569	608000
2	Uttar Pradesh & Uttarakhand	82953	24089000	290	14981000000	180596	4818000
3	Bihar & Jharkhand	27686	6132000	221	4325000000	156216	1226000
4	West Bengal	12943	3077000	238	2253000000	174071	615000
5	Rajasthan	12989	3130000	241	2093000000	161136	626000
6	Madhya Pradesh	9251	2066000	223	1380000000	149173	413000
7	Himachal Pradesh	113	39000	345	27000000	238938	8000
8	Delhi	530	167000	315	96000000	181132	33000
	Ganga Basin	**153324**	**41742000**	**272**	**26896000000**	**175419**	**6347000**
Source: Central Pollution Control Board							

113. The wastewater draining out from the irrigated fields through subsurface seepage as well as overland flow within the Ganga basin is estimated to be 26.9 billion cubic metres per year. The wastewater discharge from each square kilometre of the irrigation command area comes to 175,419 cubic metres per annum. The estimated flow of wastewater from different states within the Ganga basin is given in **Table 2.29**. The salts carried by the wastewater in the basin are estimated to be not less than 6.3 million tonnes per annum.

114. Continued irrigation over the years has contributed to building up of the salt and alkali levels in the cultivated soils. In the entire irrigation command area, especially in areas where the drainage is poor, the salinity level and alkali status in the soils rises to an appreciable degree. In certain areas, the soils are thus rendered infertile (usar) and alkali-affected (reh) as found in Haryana and Western Uttar Pradesh. From these areas there is constant subsurface

seepage and the flow of wastewater here is charged with salts and alkalis, which eventually find their way to the river waters in the Ganga basin.

115. It has already been noted that the excess of salts coming from irrigation water is largely responsible for raising the salinity level in the Ganga River between Haridwar and the Kachla Bridge site, situated some 120 km northeast of Agra, just across the Ganga-Yamuna doab. It is also possible that the seepage water from the intensively irrigated agricultural fields of the upper Ganga-Yamuna doab and Rohilkhand plains are responsible for the highest salinity recorded in the Ganga water occurring here at Kachla Bridge.

116. As regards the alkalinity status in the Ganga water, there is also a consistent upward trend from Haridwar to Kachla Bridge. Further downstream, there is a fall in the concentration of alkalinity, ranging between 100 milligrams per litre (August) and 120 milligrams per litre (May) at Kannauj. Thereafter, the alkalinity level is about 100 milligrams per litre level till Rajmahal is reached. As the Ganga enters the delta at Farakka, further fall is registered and the alkalinity levels are in the downward range of 70 milligrams to 80 milligrams per litre.

2.18 CONTAMINATION FROM PESTICIDES

117. Because the application of pesticides in the Ganga basin is only 6 per cent of the total Indian consumption of pesticides, the impact of pesticide use on the stream water quality of the Ganga has not been adequately studied so far, particularly in regards the pesticide levels in the Ganga water.

118. Pesticides have been widely used particularly in the intensely irrigated areas and in the districts growing the high-yielding varieties of crops. The quantity of pesticides used in the farm lands is much less than the total amount of the chemical fertilizers used. But the pesticides are highly toxic and chemically more stable than the fertilizer residues. If pesticide residues, occurring in the farm wastewater effluents, find way to the surface water systems, even in trace(s), it can adversely affect human health when used as a drinking water source. Even traces of pesticides in water may cause the total annihilation of aquatic fauna. In waters meant for use as a public water supply source there should not be any contamination whatsoever originating from pesticides, according to the Indian Standards Institution (1982). Despite this mandate, there is evidence of harmful pesticide contamination of surface water and groundwater that has recently come to light.

SECTION 3
GANGA BASIN – POLLUTION ASPECTS

3.1 ORGANIC POLLUTION HAZARD

119. The Ganga basin has some 1949 cities and towns, with an estimated population of 129 million. The data relating to urban wastewater discharges in the Ganga basin in terms of biochemical oxygen demand (BOD) load released from each town are given in **Tables 3.1 & 3.2**. The actual discharge points are shown on **Exhibit 9**. The district wise totals of the urban organic pollution loads have been graphically shown on **Exhibit 10**. More recent data on BOD and DO is presented in Figures 3.1 and 3.2.

120. The total urban organic pollution load in the Ganga basin is of the order of 2.5 million kilograms of BOD a day, 53.4 per cent (1.3 million kg) of which is contributed by the domestic sector and the remaining 46.6 per cent (1.2 million kg) comes from the industrial sector.

Table 3.1 Distribution of Towns and Cities in the Ganga Basin (2001)

S. No.	State	Total number of towns and cities	Total Population	Per cent of total population in basin	Number of cities*	City* population
1	Haryana	97	6115304	4.79	19	4437295
2	Uttar Pradesh & Uttarakhand	670	34539582	27.03	54	21377399
3	Bihar & Jharkhand	120	8681800	6.79	19	5144150
4	West Bengal	239	22427251	17.55	27	18728215
5	Rajasthan	239	26548541	20.78	20	7561381
6	Madhya Pradesh	368	15967145	12.50	26	8842338
7	Himachal Pradesh	56	595581	0.47	1	144975
8	Delhi	4	12905780	10.10	1	12877470
	Ganga Basin	**1793**	**127780984**	**100.00**	**167**	**79113223**

*Each with population 100,000 and over. Source: Estimated from Census of India 2001.

Table 3.2 Urban Organic Pollution (BOD) Load in the Ganga Basin (1977)

S. No.	State	Urban Load (Kilograms per day)			Per Cent of Total Load		Total BOD per Urban Citizen (grams / day)
		Total Load	Domestic Load	Industrial Load	Domestic Load	Industrial Load	
1	Haryana	77107	47250	29857	61.30	38.7	77
2	Uttar Pradesh & Uttarakhand	1329674	455859	873815	34.30	65.7	95
3	Bihar & Jharkhand	174862	91798	83064	52.50	47.5	31
4	West Bengal	442636	310751	131885	70.20	29.8	61
5	Rajasthan	75054	59400	15654	79.10	20.9	36
6	Madhya Pradesh	143303	118790	24513	82.90	17.1	38
7	Himachal Pradesh	4138	4138	0	100.00	0	42
8	Delhi	257952	250500	7452	97.10	2.9	48
	Ganga Basin	**2504726**	**1338486**	**1166240**	**53.4**	**46.6**	**64**

Source: Central Pollution Control Board

Figure 3.1: DO Levels in Ganga (Source: CPCB 2009)

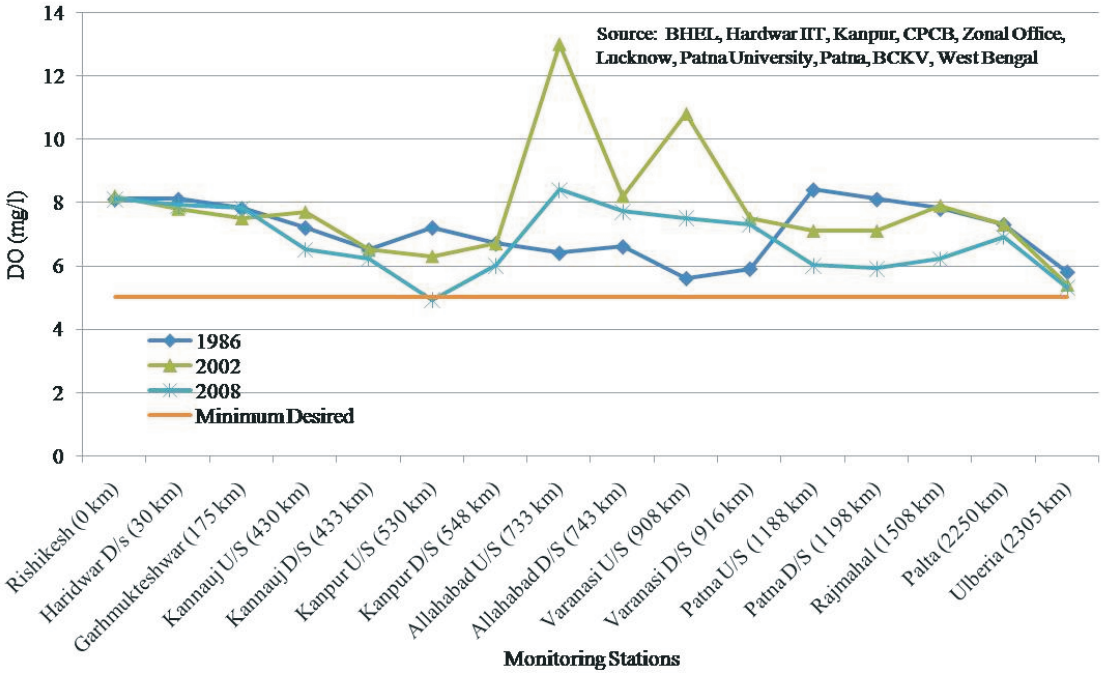
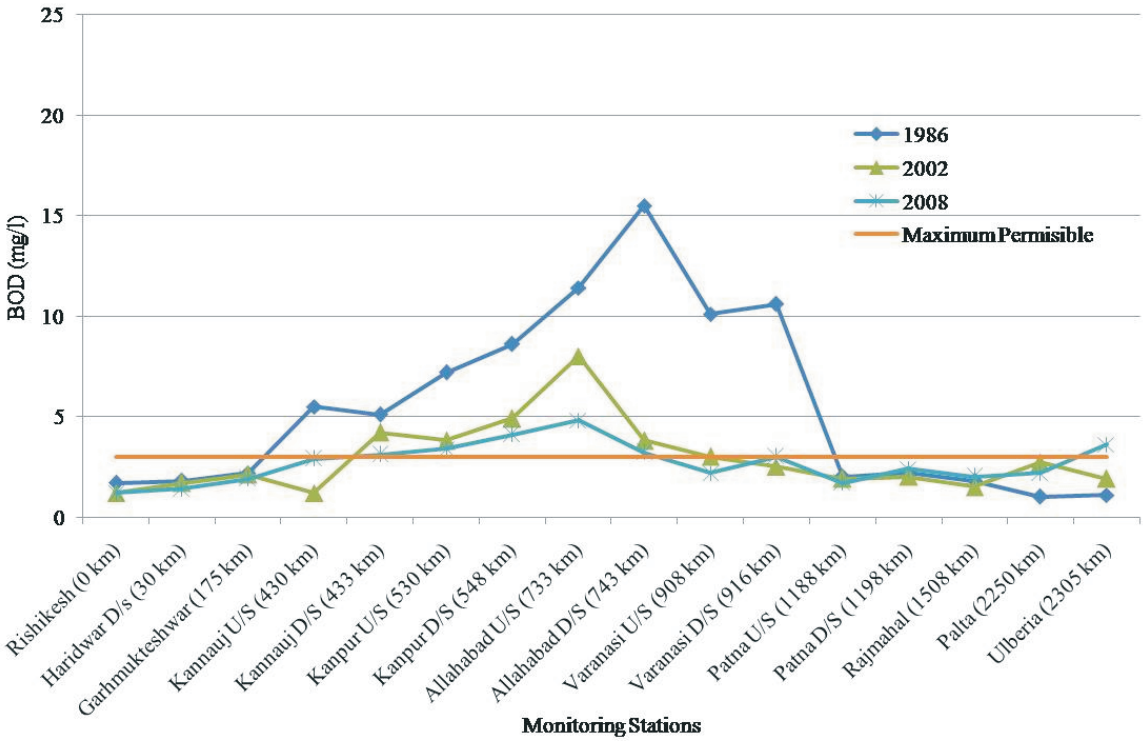


Figure 3.2: BOD Levels in Ganga (Source: CPCB 2009)



121. It can be seen from **Table 3.2** that within the Ganga basin, the highest contribution (53 per cent) of urban organic pollution load (BOD in kilograms per day from both domestic and industrial sources) by a long way comes from from Uttar Pradesh (1.3 million kg). It is also interesting to note that while in other States the contribution coming from the urban domestic sector is higher

than from the industrial sector, in Uttar Pradesh the pollution load of the industrial sectors (65.7%) is more than that of domestic sectors (34.3%). The per capita organic pollution load generated, varies considerably in the Gangetic states (**Table 3.2**). The average per capita load ranges from 31 grams (Bihar) to 95 grams (Uttar Pradesh). Taking the basin as a whole, the daily average comes to 64 grams per person in urban areas. As evidenced by the recent data presented in Figures 3.1 and 3.2, in 22 years of monitoring at 16 stations, the value of DO below 5.0 mg/l was recorded only in 2.6% cases. In these cases, the values were between 3.2 and 4.9 mg/l. These were observed between Kannauj and Kanpur. The variation in BOD values is much higher as compared to DO. Detailed perusal, station wise and year wise, reveals that the values exceeded the acceptable standard (3.0 mg/l) at Rishikesh and Haridwar only once and twice respectively whereas between Kannauj and Kanpur the values exceeded the acceptable level frequently. Higher values of BOD were also recorded at Allahabad and Varanasi. The most critical stretch is between Kannauj and Allahabad downstream. The highest value of BOD (65.8 mg/l) was recorded at Kanpur during lean flow.

122. The quantum of organic pollution load in each urban locality is relevant for assessing the water pollution hazard, but the actual manner of disposal of the load is of greater importance for control and management of pollution. In many towns within the basin, a substantial amount of the load is discharged directly into the water bodies, causing great stream pollution.

123. On account of the large rural population (202.9 million), a significant amount of organic waste is generated in the rural villages, with a total of 3.04 million kilograms of BOD per day (refer **Table 3.3**). However, because this load is distributed over more than 200,000 villages, and because in the rural areas, the disposal of waste occurs more on land than directly into water bodies, the waste is dispersed over the much wider territory of the entire basin, reducing the hazard considerably. Still, there are certain rural settlements where the density of the rural population is high enough to require a more organized treatment and disposal of the organic wastes generated from the rural community.

Table 3.3 Rural Organic Pollution (BOD) Load in the Ganga Basin (1977)							
S. No.	State	Rural BOD Load (kilograms per day) Generated from			Per Cent of Total Load		Total BOD per Rural Inhabitant (grams / day)
		Total Load	Human Origin	Cattle Origin	Human Origin	Cattle Origin	
1	Haryana	100138	49551	50587	49.48	50.52	30
2	Uttar Pradesh & Uttarakhand	2017991	1262683	755308	62.57	37.43	24
3	Bihar & Jharkhand	1340167	963175	376992	71.87	28.13	21
4	West Bengal	478101	354290	123811	74.10	25.90	20
5	Rajasthan	410393	155837	254556	37.97	62.03	40
6	Madhya Pradesh	527488	242924	284564	46.05	53.95	33
7	Himachal Pradesh	18966	5967	12999	31.46	68.54	48
8	Delhi	11505	8415	3090	73.14	26.86	21
	Ganga Basin	**4904749**	**3042842**	**1861907**	**62.04**	**37.96**	**24**
Source: Central Pollution Control Board							

Similarly, the total amount of wastes generated by the domestic animals, especially by the large herds of cattle and buffalo in the Ganga basin, would also be an equally dangerous186 million kilograms of BOD per day (**Table 3.3**), were it not too widely distributed over the land surface or systematically collected used up as a fuel in the form of dung cakes. As a result, very little of it finds its way into streams. But in the urban and suburban situations, where there are large dairies, feed lots, slaughter houses or tanneries, the impact of the organic load on the environment as well as stream pollution is significant.

124. The cattle (including buffalo) population in the Ganga basin is evenly spread out, with 152 heads to a square kilometre on an average. District wise distribution of cattle has been graphically indicated on **Exhibit 10**. It can be observed wherein the table, that the highest concentration of cattle population is in Bihar (182 heads/ Sqkm) and the lowest is in the uplands of Madhya Pradesh (94 heads/Sqkm).

125. To sum up the overall organic pollution hazard within Ganga basin, the total load in terms of the BOD originating from different sources is estimated to be as high 7.4 million kilograms per day (**Table 3.4**). The largest share, of the total basin load (66.2 per cent), comprising 4.9 million kilograms of BOD per day, comes from the wastes generated in the rural sector, comprising contribution from both human and domestic cattle sources. Only one-third (33.8 per cent) of the basin total (2.5 million kilograms of BOD per day) comes from the urban sector, comprising contribution from both the urban domestic and industrial waste products of different kinds. The overall per capita production of the organic pollution loads from urban and rural sources given in **Table 3.4**.

Table 3.4 Organic Pollution (BOD) Load Generated from Urban and Rural Sectors in the Ganga Basin (1977)							
S. No.	State	BOD Load (kilograms per day)			Per Cent of Total Basin Load	Rate of BOD Load Generation per day	
		Urban Sector	Rural Sector	Total Load		Per Person (Grams)	Per SqKm (kilograms)
1	Haryana	77107	100138	177245	2.39	41	8.3
2	Uttar Pradesh & Uttarakhand	1329674	2017991	3347665	45.18	34	11.4
3	Bihar & Jharkhand	174862	1340167	1515029	20.45	21	11.0
4	West Bengal	442636	478101	920737	12.43	30	18.2
5	Rajasthan	75054	410393	485447	6.55	39	4.7
6	Madhya Pradesh	143303	527488	670791	9.05	34	3.3
7	Himachal Pradesh	4138	18966	23104	0.31	47	4.0
8	Delhi	257952	11505	269457	3.64	45	181.5
	Ganga Basin	**2504726**	**4904749**	**7409475**	**100**	**31**	**9.1**
	Per cent of Total Basin Load	**33.8**	**66.2**	**100**			
Source: Central Pollution Control Board							

126. The rate of BOD generation per square kilometre is obviously the highest in Delhi, with a coverage of 181.5 km of BOD / SqKm. With the exception of Delhi, the rate of generation of organic waste is the highest in West Bengal at 18.2 kilograms per day to a square kilometre of land - double the average rate for the entire basin. Elsewhere, in Ganga basin, the BOD generation rate is much less: 11.4 kg/sqkm in Uttar Pradesh, 11 kg/sqkm in Bihar and 8.3 kg/sqkm in Haryana. The average BOD generation rate over the entire Ganga basin is estimated to be 9.1 kilograms to a square kilometre per day. The fecal coliform counts exceeded the stipulated limit at Kannauj, Kanpur, Allahabad and Varanasi. It is also observed that standards for coliforms are exceeded more frequently than for BOD and DO. Thus coliform and BOD emerge as the most critical parameters of river pollution. According to the recent report by CPCB, the municipal waste water discharge into the Ganga from Class I cities is 2561.7 million litres per day (MLD), and there is 1174.4 MLD waste water treatment capacity (45.8% of the discharge). The sewage generated in the cities like Patna (249.2 MLD), Kanpur (339.3 MLD), Allahabad (208.0 MLD), Varanasi (187.1 MLD), Kolkata (618.4 MLD), and Howrah (136.2 MLD) is much more than the existing capacity for sewage treatment plants in these major cities—Patna (43.7%), Kanpur (50.4%), Allahabad (42.8%), Varanasi (75.3%), Kolkata (27.8%) and Howrah (46.9%). It is pertinent to mention that waste water in Kolkata and Howrah is discharged into the estuarine part of the river. About 121.9 MLD of waste water is generated in Class II cities, and treatment capacity available is only 16.4 MLD, which is 13.5% of the total waste water generated. The contribution of Class II cities to sewage generation is as low as 4.76% (comparative values compared to big cities) compared to sewage generated by Class I cities. It is observed that the industrial effluent generated is 10.65% of the municipal sewage generated. The Ganga in Uttar Pradesh demands

treatment of sewage and minimum ecological flow for its survival as a river. Since a river is a living eco-system and therefore ultimate goal should be to protect the functioning of the river eco-system. The increasing trend of Faecal Coliform in Uttarakhand in Alakananda, Mandakini and Bhagirathi downstream of Gangotri is observed. In Uttar Pradesh increasing trend of BOD and Faecal Coliform is observed from Garhmukteshwar to Tarighat reflecting entire length in the state. In Bihar stretch of the river level of BOD is although confirming to standard but increasing trend is clearly seen. Whereas, Faecal Coliform is not confirming to standard and shows an increasing trend. In West Bengal although a decreasing trend is observed with respect to Faecal Coliform, it is exceeding the standard at all locations. The water quality needs improvement in Uttrakhand from downstream of Rudrapryag, in Uttar Pradesh from Garhmukteshwar to Tarighat, in Bihar from Buxar to Kahalgaon and in West Bengal from Behrampore to Diamond Harbour on priority basis. An assessment of flow and wastewater is necessary.

3.2 GENERATION OF WASTEWATER

127 The consumption of fresh water for various purposes in the Ganga basin is estimated to be of the order of 142.6 billion cubic metres being used annually to meet the requirement of the various sectors of the economy. The estimated quantity of water used in irrigation, domestic purpose and industrial activities for each State in the Ganga basin is given in **Table 3.5**. Among the states, Uttar Pradesh accounts for 55.8 per cent of the total consumption within the basin. Also, the largest share of water consumption is for irrigation purposes (94.28 per cent), whereas domestic consumption is only 2.9 per cent.

Table 3.5 Annual Consumption of Fresh Water and Generation of Wastewater in the Ganga Basin (Million cubic metres)

S. No.	State	Consumption of Fresh Water				Generation of Waste Water		
		Irrigation Use	Domestic Use	Industrial and Other Uses	Total Annual Consumption	From Irrigated Fields	From Other Sources	Total Annual Generation
1	Haryana	8706	56	63	8825	1741	21	1762
2	Uttar Pradesh & Uttarakhand	74907	1692	3042	79641	14981	528	15509
3	Bihar & Jharkhand	21625	793	289	22707	4325	128	4453
4	West Bengal	11267	680	459	12406	2253	317	2570
5	Rajasthan	10465	187	51	10703	2093	74	2167
6	Madhya Pradesh	6898	296	69	7263	1380	108	1488
7	Himachal Pradesh	135	6	1	142	27	2	29
8	Delhi	481	443	26	950	96	350	446
	Ganga Basin	**134484**	**4153**	**4000**	**142637**	**26896**	**1528**	**28424**
	Per Cent of Total Consumption	**94.28**	**2.91**	**2.8**	**100**	**18.86**	**1.07**	**19.93**

Source: Central Pollution Control Board

128. The irrigation sector alone requires a total quantity of 134.5 billion cubic metres of fresh water in a year (**see Table 3.5**). Out of this, a substantial quantity of water is held back as soil moisture and a portion is lost through evaporation and transpiration; still, there is a potential balance of nearly 20

per cent of the total supply which drains off from the irrigated tracts by subsurface seepage and overland flow as wastewater, gravitating towards the natural drainage systems. The wastewater flow generated from the irrigated fields thus is estimated to be of the order of 26.9 billion cubic metres per annum, whereas the total wastewater is some 28.4 billion cubic metres per annum, within the Ganga basin, which represents some 20% of total consumption.

3.3 URBAN AND INDUSTRIAL WASTEWATER

129. An estimated 4153.8 million cubic metres of water is consumed annually for various domestic uses in the Ganga basin. Out of this, the rural areas consume some 1851 million cubic metres per year (44.5%), whereas the urban areas consume 2302.8 million cubic metres per annum (55.5%). The consumption of water in the rural and urban areas in each state is indicated in **Table 3.6**.

Table 3.6 Domestic Water Supply and Urban Wastewater Generation in the Ganga Basin

S. No.	State	Annual Water Supply (Million Cum)			Urban Supply Per Capita (litre per day)	Waste Water Generation from Urban Areas		
		Total Supply	Rural Domestic	Urban Domestic		Annual Flow (Million Cum)	Rate of Flow (Litres per Second)	BOD Flux in Wastewater (Kilograms per Second)
1	Haryana	56.082	30.144	25.938	71	20.751	658	0.359
2	Uttar Pradesh & Uttarakhand	1692.171	768.132	924.039	163	528.084	16745	12.616
3	Bihar & Jharkhand	793.470	585.931	207.539	101	128.274	4068	1.238
4	West Bengal	679.794	215.526	464.268	175	317.056	10054	4.387
5	Rajasthan	186.830	94.800	92.030	120	73.624	2335	0.602
6	Madhya Pradesh	296.252	147.779	148.473	109	107.934	3423	0.637
7	Himachal Pradesh	6.109	3.630	2.479	69	1.984	63	0.022
8	Delhi	443.119	5.119	438.000	223	350.400	11111	2.894
	Ganga Basin	**4153.827**	**1851.061**	**2302.766**	**154**	**1528.107**	**48457**	**22.755**

Source: Central Pollution Control Board

130. The water supplied in urban areas for each district has been shown by proportional bars in blue colour on **Exhibit 10**. A significant portion (69 per cent) of the urban water supply eventually goes down the drain as wastewater, as indicated for each district by the bars in black screen in **Exhibit 10**. Nevertheless, the total quantity of fresh water used in the domestic (2.9%) and industrial sectors (2.8%) is much less than that consumed in irrigating the crop lands. Despite consuming less freshwater, the wastewater released from these two sectors has a greater concentration of pollutants and is usually discharged at specified disposal points. Thus, the wastewaters generated from the domestic and industrial sectors are much bigger sources of pollution.

131. The urban areas in the Ganga basin generate some 1528.1 million cubic metres of wastewater per annum. State-wise annual generation of urban wastewater is indicated in **Table 3.6**. It can be seen that more than a third of the total amount of wastewater generation in the basin is contributed by Uttar Pradesh alone (528.1 million cum per annum). The flux of BOD in the urban wastewater within the Ganga basin is some 22.8 kilograms per second, the major share of which is contributed by Uttar Pradesh (12.6 kilograms per second) alone.

132. As per the data already given in **Section 3.1 (Table 3.1 & 3.2)**, some 1793 urban areas and numerous industrial plants distributed all over the Ganga basin. The total quantity of organic pollution load in terms of the biochemical oxygen demand (BOD), contributed by all these urban areas and industrial units, is estimated to be of the order of 2.5 million kilograms in a day (**Table 3.2**). The organic pollution load (BOD) contributed daily by the urban domestic sector alone comes to 53.4 per cent (1.33 million kilograms) and the remaining 46.5 per cent (1.17 million kilograms) from the industrial sources within the basin. In addition, the industrial effluents also carry various toxic pollutants, of which detailed information is not available at present. The effluents originating from the industrial sector need much more careful handling and treatment prior to disposal. Hence the industrial effluents should be regularly monitored and assessed for controlling pollution in the river water.

133. State-wise breakup of the pollution load contributed by urban domestic and industrial sectors has been given in **Table 3.2**. The organic pollution load contributed by each district within the basin is also graphically represented on **Exhibit 10** and the liquid waste discharge points are shown by arrows on **Exhibit 11**. Among the states, Uttar Pradesh alone contributes more than 55 per cent of the total urban industrial pollution load within the basin.

134. In the entire Ganga basin, some 1529 million kilolitres of wastewater are generated every day from towns and cities at a rate of 48,457 litres per second for discharge into the final disposal areas, either on land or into the surface water systems. Out of this, about 47.1 per cent of the urban wastewater finds its way to overland trenching, low lying areas or treatment plants, while a larger share - nearly 52.9 per cent - is directly discharged into the surface water systems without any treatment.

135. The estimated BOD load of these urban domestic and industrial wastewaters generated in the Ganga basin works out to 1965.9 tonnes of BOD per day for

final disposal either on land (926.5 tonnes, or 47.1%) or on surface water (1039.4 tonnes, or 52.9%). BOD load generation and its mode of disposal, within the Ganga basin is given in **Table 3.7**

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Table 3.7 Origin and Destination of Urban Organic Pollution (BOD) Discharge

S. No.	State	Origin of BOD Discharge (Kilograms per day)		Total BOD Discharge (kg / day)	Destination of BOD Discharge (Kilograms per day)		BOD Content in Wastewater (Milligrams per Litre)
		Domestic	Industrial		Surface Water	Land	
1	Haryana	19335 (62.4)	11665 (37.6)	31000	31000 (100)	0 (0)	545
2	Uttar Pradesh & Uttarakhand	371626 (34.1)	718274 (65.9)	1090000	275000 (25.2)	815000 (74.8)	737
3	Bihar & Jharkhand	56172 (52.5)	50828 (47.5)	107000	99000 (92.5)	8000 (7.5)	304
4	West Bengal	266076 (70.2)	112924 (29.8)	379000	379000 (100)	0 (0)	436
5	Rajasthan	40712 (78.3)	11288 (21.7)	52000	51000 (92.1)	1000 (0.9)	258
6	Madhya Pradesh	43591 (79.3)	11409 (20.7)	55000	30000 (54.5)	25000 (46.5)	166
7	Himachal Pradesh	1900 (100)	0 (0)	1900	1900 (100)	0 (0)	350
8	Delhi	242565 (97.0)	7435 (3.0)	250000	172000 (69.0)	77500 (31.0)	261
	Ganga Basin	**1027830 (52.3)**	**938070 (47.7)**	**1965900**	**1039400 (52.9)**	**926500 (47.1)**	**461**

Figures in Parentheses Indicate Per Cent of the Total BOD Discharge
Source: Central Pollution Control Board

Though a substantial amount of urban and industrial fluid waste is discharged into the surface water, this does not necessarily mean that the entire quantity directly finds its way to the river systems. In certain cases, the wastewater may actually be diverted into marshes or low lying areas, some of which overflow only during the rainy season. However, in quite a large number of cases, the wastewater discharge finds its way into the rivers, resulting direct pollution of the river water in the Ganga basin.

3.4.1 Urban Population of Ganga Basin

136. The Ganga basin has 234 Class I cities (Population 1,00,000 and above) and 149 Class II cities (Population between 50,000 – 99,999), with a total population of 109.8 million . The State-wise population of Class I & Class II cities is given in **Table 3.8**.

Table 3.8 Urban Centres and Status of Sewage Generation and treatment in Class I & Class II Cities

S. No.	State/UT	No. of cities	Population (in year 2008)	Sewage generation (in MLD)	Sewage treatment capacity (in MLD)
A	**Class I cities**				
1	Bihar & Jharkhand	37	10747725	1840.17	135.5
2	Delhi	1	14858800	3800	2330
3	Haryana	20	5494110	626.69	312
4	Himachal Pradesh	1	163490	28.94	35.63
5	Madhya Pradesh	25	10795000	1248.72	186.1
6	Rajasthan	24	9611490	1382.37	54
7	Uttar Pradesh & Uttarakhand	66	27011660	3682.98	1258.13
8	West Bengal	60	19818471	2345.21	505.92
	Ganga Basin	234	98500746	14955.08	4817.28
B	**Class II cities**				
1	Bihar & Jharkhand	24	1940100	185.63	2
2	Haryana	7	544040	43.52	-
3	Madhya Pradesh	23	1745050	130.9	9
4	Rajasthan	21	1599260	147.79	-
5	Uttar Pradesh & Uttarakhand	47	3452010	354.14	18.94
6	West Bengal	27	2004440	180.42	61.88
	Ganga Basin	149	11284900	1042.4	91.82

Source: Central Pollution Control Board

The city-wise (Class I & Class II) information on population in Ganga basin, is given in **Appendix 5**.

3.4.2 Status of Water Supply

137. Out of the 232 Class I cities and 149 Class II cities in Ganga basin, nearly 35% of the population is covered by organized water supply with an average per capita water supply of 195 litres (min. 12 litres and max. 650 litres) in Class I cities and 115 litres (min. 8 litres and max. 757 litres) in Class II cities.

The statewise cities (Class I & Class II) and their water supply levels are given in **Table 3.9**.

Table 3.9 Distribution of Class I & Class II Cities according to State-wise and Per Capita Water Supply								
S.NO	State/UT	No of cities	Municipal Population in Year 2008	No of cities in different categories of per capita water supply (lpcd)				Percent Population covered by organised water supply
				<100	Between 100-200	Between 200-300	>300	
A	**Class I cities**							
1	Bihar & Jharkhand	37	10747725	-	11	26	-	3%
2	Delhi	1	14701150	-	-	1	-	100%
3	Haryana	20	5494110	2	16	1	1	12%
4	Himachal Pradesh	1	163490	-	-	1	-	-
5	Madhya Pradesh	25	10795000	10	14	1	-	41%
6	Rajasthan	24	9611490	9	14	1	-	20%
7	Uttar Pradesh & Uttarakh	65	26346330	7	52	5	1	6%
8	West Bengal	59	19699751	17	38	1	3	56%
	Ganga Basin	232	97559046	45	145	37	5	
B	**Class II cities**							
1	Bihar & Jharkhand	24	1940100	-	24	-	-	2%
2	Haryana	7	544040	7	-	-	-	10%
3	Madhya Pradesh	23	1745050	18	4	1	-	31%
4	Rajasthan	21	1599260	18	2	-	1	47%
5	Uttar Pradesh & Uttarakh	47	3451980	3	44	-	1	23%
6	West Bengal	27	2004440	4	21	2	-	35%
	Ganga Basin	149	11284870	50	95	3	2	
Source: Central Pollution Control Board								

* Data is not available for one class I city in Uttar Pradesh and one class I city in West Bengal

The statewise water supply in Class I & Class II cities is given in **Appendix 6**.

3.4.3 Status of Waste Water Generation and Collection

138. The estimated waste water sewage generated from Class I and Class II cities within Ganga basin is given in **Table 3.10**. The city-wise data on waste water generation is given in **Appendix 5**.

Table 3.10 Status of Wastewater Generation and treatment in Class I & Class II Cities in Ganga Basin						
S. No.	**State/UT**	**No. of cities**	**Population (in year 2008)**	**Sewage generation (in MLD)**	**Per capita sewage generation (lpcd)**	**Sewage treatment capacity (in MLD)**
A	**Class I cities**					
1	Bihar & Jharkhand	37	10747725	1840.17	171.214838	135.5
2	Delhi	1	14858800	3800	255.740706	2330
3	Haryana	20	5494110	626.69	114.06579	312
4	Himachal Pradesh	1	163490	28.94	177.013885	35.63
5	Madhya Pradesh	25	10795000	1248.72	115.675776	186.1
6	Rajasthan	24	9611490	1382.37	143.824735	54
7	Uttar Pradesh & Uttarakhand	66	27011660	3682.98	136.347785	1258.13
8	West Bengal	60	19818471	2345.21	118.334558	505.92
	Ganga Basin	234	98500746	14955.08	151.827073	4817.28
B	**Class II cities**					
1	Bihar & Jharkhand	24	1940100	185.63	95.680635	2
2	Haryana	7	544040	43.52	79.9941181	-
3	Madhya Pradesh	23	1745050	130.9	75.0121773	9
4	Rajasthan	21	1599260	147.79	92.4114903	-
5	Uttar Pradesh & Uttarakhand	47	3452010	354.14	102.589506	18.94
6	West Bengal	27	2004440	180.42	90.0101774	61.88
	Ganga Basin	149	11284900	1042.4	92.3712217	91.82
C	**Sewage Treatment Capacity Created Under Ganga Action Plan**					
1	Sewage treatment capacity created under Ganga Action Plan Phase-I					882 mld
2	Sewage treatment capacity created along the River Yamuna					2631 mld
3	Sewage treatment capacity being created in additional towns (48 towns) under Ganga Action Plan, Phase II					(600 mld)
4	Sewage treatment capacity being created in number of towns (23 towns) on tributaries of the Ganga					(750 mld)
Source: Central Pollution Control Board						

3.4.4 Status of Sewage Treatment

139. The status of sewage treatment in Class I and Class II cities of Ganga basin is given in **Table 3.11**.

Table 3.11 Status of Wastewater Generation, Collection and Treatment in Class I & Class II Cities in Ganga Basin

S. No.	State/UT	No. of cities	Population (in year 2008)	Sewage generation (in MLD)	Sewage treatment capacity (in MLD)	Capacity gap (MLD)	Percent treatment capacity
A	**Class I cities**						
1	Bihar & Jharkhand	37	10747725	1840.17	135.5	1704.67	7%
2	Delhi	1	14858800	3800	2330	1470	61%
3	Haryana	20	5494110	626.69	312	314.69	50%
4	Himachal Pradesh	1	163490	28.94	35.63	0	100%
5	Madhya Pradesh	25	10795000	1248.72	186.1	1062.62	15%
6	Rajasthan	24	9611490	1382.37	54	1328.37	4%
7	Uttar Pradesh & Uttarakhand	66	27011660	3682.98	1258.13	2424.85	34%
8	West Bengal	60	19818471	2345.21	505.92	1839.29	22%
	Ganga Basin	234	98500746	14955.08	4817.28	10137.8	32%
B	**Class II cities**						
9	Bihar & Jharkhand	24	1940100	185.63	2	183.63	1%
10	Haryana	7	544040	43.52	-	43.52	0%
11	Madhya Pradesh	23	1745050	130.9	9	121.9	7%
12	Rajasthan	21	1599260	147.79	-	147.79	0%
13	Uttar Pradesh & Uttarakhand	47	3452010	354.14	18.94	335.2	5%
14	West Bengal	27	2004440	180.42	61.88	118.54	34%
	Ganga Basin	149	11284900	1042.4	91.82	950.58	9%

Source: Central Pollution Control Board

The city-wise status of sewage generation in Class I & Class II cities having no sewage treatment facility is given in **Appendix 7**.

3.4.5 Status of Sewage Generation & Disposal

140. The 179 Class I cities and 147 Class II cities within Ganga basin, put to gather generate about 12410.5 mld of sewage. The statewise sewage generation and mode of disposal is given in **Tables 3.12** and **3.13**.

Table 3.12 State-wise Distribution of Class I & Class II Cities According to Mode of Disposal							
S.NO	State/UT	No. of cities	Municipal Population	Volume of waste water generated (MLD)	No of cities with various mode of disposal		
					Ganga river	Other rivers (tributaries)	Land
A	**Class I cities**						
1	Bihar & Jharkhand	24	7399891	1045.6	4	16	4
2	Haryana	18	4952990	389.6	-	8	10
4	Madhya Pradesh	18	8415820	898.9	-	17	1
5	Rajasthan	7	5148920	696.5	-	5	2
6	Uttar Pradesh & Uttarakhand	55	25620720	3017.5	9	45	1
7	West Bengal	56	19422911	2197.2	23	21	12
8	Delhi	1	14858800	2948	-	1	-
	Ganga Basin	179	85820052	11193.3	36	113	30
B	**Class II cities**						
9	Bihar & Jharkhand	27	2354872	191.6	4	2	21
10	Haryana	2	180550	10.1	-	-	2
11	Madhya Pradesh	18	1513530	124.1	-	5	13
12	Rajasthan	13	1460740	122.5	-	6	7
13	Uttar Pradesh & Uttarakhand	59	4621792	411.1	9	4	46
14	West Bengal	28	2095384	164.3	1	1	26
	Ganga Basin	147	12226868	1023.7	14	18	115

Source: Central Pollution Control Board

Table 3.13 Wastewater Generation and Disposal in Ganga Basin (Class I & Class II Cities)		
Category	**Waste water Volume (MLD)**	**Disposal**
Class I (36)	2637.7	Ganga river
Class II (14)	122	Ganga river
Total	2759.7	
Class I (113)	7841.5	Other rivers (tributaries)
Class II (18)	134.6	Other rivers (tributaries)
Total	7976.1	
Class I (30)	907.4	Land
Class II (115)	767.3	Land
Total	1674.7	
Grand total	**12410.5**	
Source: Central Pollution Control Board		

3.5 WATER POLLUTION

3.5.1 Polluted River Stretches

141. The water quality data generated through the National Water Monitoring Programme and River Basin Studies carried out since 1980 describes the deterioration of water quality in riverine segments and other water bodies. Those water bodies not meeting the desired water quality criteria are identified as polluted river stretches/water bodies. The deviation of water

quality from the desired water quality criteria in the data generated for the river Ganga formed the basis for launching Ganga Action Plan (GAP) and the subsequent National River Conservation Plan. The list of polluted stretches increased to 37 during the year 1992 covering all the major river basins. The State-wise polluted stretches in rivers and lakes within Ganga basin are given in **Table 3.14**. The river-wise 'polluted stretches' within Ganga basin are given in **Appendix 8**.

Table 3.14 Statewise Polluted Stretches in Rivers and Lakes within Ganga Basin

S. No.	Name of State	No. of Water Bodies	River	Lake / Tank / Drain etc.
1	Bihar	Information not available (possibly no polluted stretches within the State)		
2	Uttarakhand	Information not available (possibly no polluted stretches within the State)		
3	Jharkhand	1	1	–
4	Delhi	1	1	–
5	Haryana	3	2	1
6	Himachal Pradesh	2	1	1
7	Madhya Pradesh	5	4	1
8	Rajasthan	3	3	–
9	Uttar Pradesh	8	8	–
10	West Bengal	1	1	–
	Total - Ganga Basin	**24**	**21**	**3**
	Total - India as a Whole	**86**	**71**	**15**

Source: Central Pollution Control Board

3.6 WATER QUALITY MONITORING IN GANGA BASIN

142. The Central Pollution Control Board (CPCB) in collaboration with concerned State Pollution Control Boards (SPCBs) and Pollution Control Committees (PCCs) has established a nationwide network of water quality monitoring comprising 1245 stations in 27 States and 6 Union Territories. The monitoring is done on monthly or quarterly basis in surface waters and on a semi-annual basis for groundwater. The monitoring network covers 250 Rivers, 79 Lakes, 6 Tanks, 26 Ponds, 8 Creeks, 19 Canals, 18 Drains and 382 Wells. Among the 1245 stations, 695 are on rivers, 87 on lakes, 18 on drains, 19 on canals, 6 on tank, 12 on creeks/seawater, 26 on pond and 382 are groundwater stations.

The waterbody-wise distribution of Water Quality Monitoring Stations across India is given in **Table 3.15**. The statewise, water body wise and river basin-wise distribution of water quality monitoring stations on all India basis is given in **Appendix 9**.

Table 3.15 Water Body wise Distribution of Water Quality Monitoring Stations			
S. No.	**Waterbody**	**No. of Stations All India Basis**	**Ganga Basin**
1	Ponds	26	0
2	Creeks	12	0
3	Tanks	6	0
4	Canals	19	13
5	Drains	18	14
6	Lakes	87	33
7	Wells	382	151
8	Rivers	695	222
	Total	**1245**	**433**
Source: Central Pollution Control Board			

Within the Ganga basin, the Water Quality Monitoring covers 222 Rivers, 151 wells, 14 drains, 13 canals and 33 lakes. The waterbody-wise distribution of Water Quality Monitoring Stations within Ganga basin is given in **Table 3.16**.

Table 3.16 Distribution of Water Quality Monitoring Stations within Ganga Basin										
S. No.	**Ganga Basin States**	**River**	**Lake**	**Tank**	**Pond**	**Canal**	**Creek / Sea**	**Drain**	**Well**	**Total**
1	Bihar	16	–	–	–	–	–	–	20	**36**
2	Delhi	4	–	–	–	2	–	9	–	**15**
3	Haryana	8	2	–	–	11	–	2	–	**23**
4	Himachal Pradesh	31	3	–	–	–	–	–	20	**54**
5	Jharkhand	9	–	–	–	–	–	–	–	**9**
6	Madhya Pradesh	69	18	–	–	–	–	–	18	**105**
7	Rajasthan	7	7	–	–	–	–	–	37	**51**
8	Uttar Pradesh	44	1	–	–	–	–	3	25	**73**
9	Uttarakhand	14	1	–	–	–	–	–	1	**16**
10	West Bengal	20	1	–	–	–	–	–	30	**51**
	Total Ganga Basin	**222**	**33**	**0**	**0**	**13**	**0**	**14**	**151**	**433**
	Total India as a Whole	**695**	**87**	**6**	**26**	**19**	**12**	**18**	**382**	**1245**
Source: Central Pollution Control Board										

Out of 155 Water Quality Monitoring Stations in Ganga basin, 39 are along main stream of Ganga and the 88 are along the tributaries and sub-tributaries of Ganga River.

3.6.1 Water Quality Parameters

143. The National Water Quality Monitoring Program is operated under a three-tier programme: Global Environment Monitoring System (GEMS), Monitoring of Indian National Aquatic Resources System (MINARS) and Yamuna Action Plan (YAP). Water samples are analyzed for 28 parameters consisting of physico-chemical and bacteriological parameters for ambient water samples apart from the field observations. Besides this analysis, 9 trace metals and 15 pesticides and bio-monitoring are also analyzed for selected samples.

The list of parameters analyzed under the National Water Quality Monitoring Programme is given in **Table 3.17**.

The water quality data are compiled in the form of National Water Quality Status year book and published by Central Pollution Control Board (CPCB).

Table 3.17 List of Water Quality Parameters Analyzed under National Water Quality Monitoring Programme

S. No.	Parameters	S. No.	Parameters
	Core Parameters (9)		**Field Observations (7)**
1	PH	1	Weather
2	Temperature	2	Depth of main stream/depth of water table
3	Conductivity, µmhos/cm	3	Colour and intensity
4	Dissolved Oxygen, mg/L	4	Odour
5	BOD, mg/L	5	Visible effluent discharge
6	Nitrate – N, mg/L	6	Human activities around station
7	Nitrite – N, mg/L	7	Station detail
8	Fecal Coliform, MPN/100 ml		**Trace Metals (9)**
9	Total Coliform, MPN/100 ml	1	Arsenic, µg/L
	General Parameters (19)	2	Cadmium, µg/L
1	Turbidity, NTU	3	Copper, µg/L
2	Phenolphthalein Alkalinity, as CaCO3	4	Lead, µg/L
3	Total Alkalinity, as CaCO3	5	Chromium (Total), µg/L
4	Chlorides, mg/L	6	Nickel, µg/L
5	COD, mg/L	7	Zinc, µg/L
6	Total Kjeldahl - N, as N mg/L	8	Mercury, µg/L
7	Ammonia - N, as N mg/L	9	Iron (Total), µg/L
8	Hardness, as CaCO3		**Pesticides (15)**
9	Calcium, as CaCO3	1	Alpha BHC, µg/L
10	Sulphate, mg/L	2	Beta BHC, µg/L
11	Sodium, mg/L	3	Gama BHC (Lindane), µg/L
12	Total Dissolved Solids, mg/L	4	O P DDT, µg/L
13	Total Fixed Dissolved Solids, mg/L	5	P P DDT, µg/L
14	Total suspended Solid, mg/L	6	Alpha Endosulphan, µg/L
15	Phosphate, mg/L	7	Beta Endosulphan, µg/L
16	Boron, mg/L	8	Aldrin, µg/L
17	Magnesium, as CaCO3	9	Dieldrin, µg/L
18	Potassium, mg/L	10	Carboryl (Carbamate), µg/L
19	Fluoride, mg/L	11	2-4 D, µg/L
	Bio-Monitoring (3)	12	Malathian, µg/L
1	Saprobity Index	13	Methyl Parathian, µg/L
2	Diversity Index	14	Anilophos, µg/L
3	P/R Ratio	15	Chloropyriphos, µg/L

Source: Central Pollution Control Board

In the present report, data on core parameters is incorporated for interpretation and drawing of conclusion based on primary water quality criteria.

3.6.2 Frequency of Monitoring

144. Frequency of monitoring station on surface water bodies such as rivers, lakes, ponds, canals and creeks is either monthly or quarterly whereas the

groundwater monitoring stations are taken on a half yearly basis. The frequency of water quality monitoring stations within Ganga basin is given in **Table 3.18** and in each State is given in **Appendix 10**.

Table 3.18 Frequency of Water Quality Monitoring Stations within Ganga Basin

S. No.	Ganga Basin States	Monthly	Half Yearly	Quarterly	Yearly	Total
1	Bihar	8	20	8	–	**36**
2	Delhi	14	–	1	–	**15**
3	Haryana	5	–	18	–	**23**
4	Himachal Pradesh	–	20	33	1	**54**
5	Jharkhand	1	–	8	–	**9**
6	Madhya Pradesh	50	18	37	–	**105**
7	Rajasthan	4	37	10	–	**51**
8	Uttar Pradesh	41	25	7	–	**73**
9	Uttarakhand	3	1	9	3	**16**
10	West Bengal	9	30	12	–	**51**
	Total Ganga Basin	**135**	**151**	**143**	**4**	**433**
	Total India as a Whole	**362**	**382**	**497**	**4**	**1245**

Source: Central Pollution Control Board

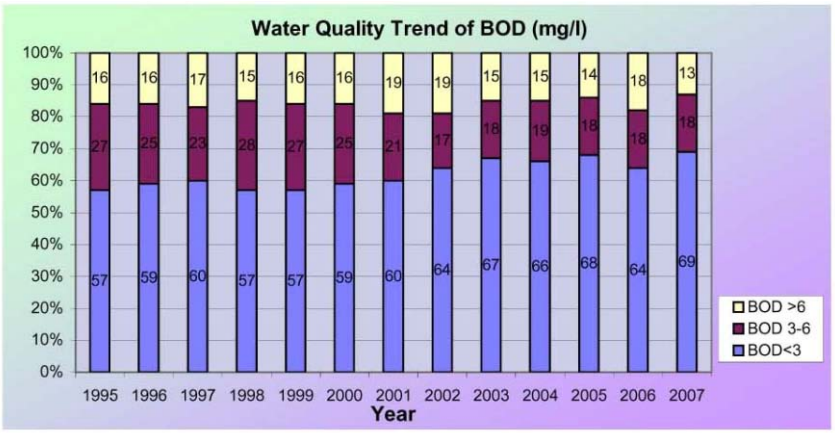
3.7 WATER QUALITY TREND – ALL INDIA BASIS

145. The National Water Quality Monitoring results recorded between 1995 & 2007 indicate that organic pollution continues to be the predominant pollutant of aquatic resources. The organic pollution measured in terms of BOD & Coliform bacterial count gives an indication of the extent of the water quality degradation in different parts of the country. In the year 2007, it was observed that nearly 69% of the observations had a BOD count of less than 3 mg/l, 18% between 3-6 mg/l & 13% above 6 mg/l. Similarly critical levels were found for Total & Faecal Coliform, indicating that the presence of pathogens in water should be a major concern. About 50% of observations in 2007 had Total Coliform and 66% observations had Faecal Coliform level less than 500 MPN /100 ml.

146. The water quality monitoring results for the period between 1995 and 2007 indicate that the organic (Bio-chemical demand) and bacterial (Total Colliform and Faecal Coliform) contamination continued to be critical in the water bodies, although there is evidence of some improvement in water quality. This is mainly due to discharge of domestic wastewater mostly in untreated form from the urban centres of the country.

3.7.1 Bio-Chemical Oxygen Demand (BOD)

147. The BOD values, observed between year 1995 and 2007 on an all India basis is given hereunder.



Water Quality Trend (BOD, mg/l) – All India basis

Source: Central Pollution Control Board

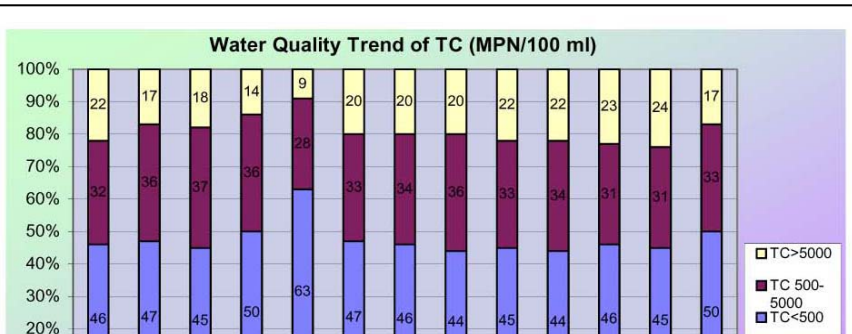
During this period, the number of observed BOD values between 3-6 mg/l ranged 17 and 28% and the maximum value of 28% was observed in the year 1998, which reduced to 18% in year 2007.

Similarly, the numbers of observed BOD value> 6 mg/l were between 13 and 19% during year 1995-2007, (maximum value of 19% was observed in 2001 and 2002), which further reduced to 14% in 2005 and subsequently decreased to 13% in 2007.

Overall, there was a gradual decrease in number of observations having BOD between 3-6 mg/l and >6 mg/l, which indicates a gradual improvement in water quality.

3.7.2 Total Coliform (TC)

148. The Total Coliform (TC) values observed between 1995 and 2007 on an all India basis is given hereunder.

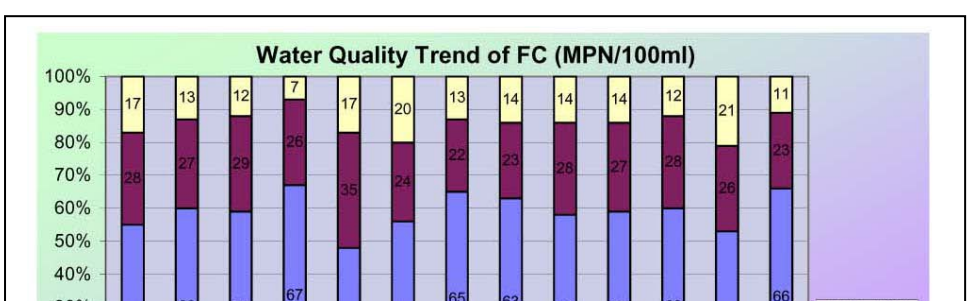


The TC values < 500 MPN/100 ml were between 44-63% during 1995-2007, gradually increasing to 63% in the year 1999 and increased to 50% during 2007. Similarly, the observed TC values between 500-5000 ranged between 28-37%, the maximum value of 37% was observed in 1997 and this figure gradually decreased to 33% in 2000, and further still to 31% in year 2006. During 2007 it was observed as 33%. It was also observed that there was a gradual decrease in the number of observations having TC < 500 MPN/100 ml.

The numbers of observed TC values > 5000 were between 9-24% during year 1995-2007. The maximum value of 24% was observed in the year 2006. A minimum value of 9% was observed during the year 1999. During 2007 it was observed as 17%, indicating decreasing trend.

3.7.3 Faecal Coliform (FC)

149. The Faecal Coliform (FC) values observed between 1995 and 2007 for all of India are given hereunder.



The FC values <500 MPN/100 ml was between 48-67% between 1995-2007. The maximum value of 67% was observed in the year 1998 that gradually decreased to 48% in 1999, which again steadily rose to 53% in 2006 and 66% in 2007.

The FC values between 500-5000 MPN/100 ml ranged between 22-35% during year 1995 to 2007, with maximum value of 35% in 1999, which gradually decreased to 26% in the year 2006 and further decreased to 23% in 2007.

The FC values with > 5000 MPN/100 ml ranged between 7-21% during year 1995-2007. A maximum value of 20% was observed in 2000, which gradually decreased to 12% in 2005, and increased again to 21% in 2006, before once more decreasing to 11% in 2007.

3.8 POLLUTED RIVER STRETCHES AND RIVER ACTION PLANS

150. The National Water Quality Monitoring data of surface water resources indicate that the major rivers of the country have retained pristine water in their upper stretches. As the rivers enter the plains, they start getting exploited for irrigation or drinking and used as receptacle for industrial and domestic wastewater. These factors have rendered the rivers polluted. The presence of organics and bacterial contamination are the critical pollution factors in these water bodies and mainly responsible for water borne diseases.

On the basis of water quality monitoring data, the Central Pollution Control Board has identified critically polluted, moderately polluted and relatively clean stretches, on an all-India basis as given in **Table 3.19**.

Table 3.19 Riverine Length having Different levels of Pollution - All India Basis			
S. No.	**Water Quality Status**	**Riverine Length (Kms)**	**Percentage Riverine Length**
1	Severely Polluted	6086	14
2	Moderately Polluted	8691	19
3	Relatively Clean	30242	67
Source: Central Pollution Control Board			

The water bodies not meeting the desired water quality criteria are identified as polluted river stretches/water bodies. The statewise polluted stretches in rivers within Ganga basin are given in **Appendix 9**.

The National River Conservation Directorate (NRCD), under the Ministry of Environment and Forests, Govt. of India is implementing the River Action Plans for the restoration of water quality based on the findings of CPCB/SPCBs. The thrust of NRCD is towards providing funds to state agencies for interception, diversion and treatment of sewage discharged to the water bodies from identified Urban Centers. At present NRCD is implementing the Action Plans in 157 cities and towns located along 30 rivers. The rivers covered under the Rivers Conservation Action Plan are Adyar, Cooum, Betwa, Bhadra, Brahmani, Cauvery, Chambal, Damodar, Ganga, Godavari, Gomti, Khan, Krishna, Kshipra, Mahanadi, Mandovi, Narmada, Pennar, Sabarmati, Satluj, Subarnarekha, Tapti, Tunga, Tungbhadra, Tambiraparni, Vennar, Vaigai, Walnganga, Yamuna and Musi.

The schemes taken up by NRCD are largely related to Municipal Wastewater Treatment and are progressing in various stages. The component of Industrial Effluents contribution to polluted stretches is required to be addressed by SPCBs through consent management, surveillance and enforcement. The SPCBs compile information on Industrial Effluents being discharged in the polluted stretches in their respective states and come out with a time targeted plan to restore the water quality in the rivers. The SPCBs may also carry out performance studies of functional Sewage Treatment Plant (STP) to evaluate the efficacy of treatment systems. This exercise is helpful in the enforcement of treatment standards imposed by SPCBs and NRCD.

3.9 APPROACH TO WATER QUALITY MANAGEMENT

1.51 The water quality management in India is performed under the provision of the Water (Prevention and Control of Pollution) Act, 1974. The basic objective of this Act is to maintain and restore the purity of national aquatic resources

by prevention and control of pollution. The Act does not define the level of purity to be maintained or restored in different water bodies of the country. The Central Pollution Control Board (CPCB) has tried to define the purity requirement in terms of the protection of human uses, and thus, has taken human uses of water as a base for identification of water quality objectives for different water bodies in the country.

It is an ambitious objective to maintain or restore all natural water body to a pristine level. Planning pollution control activities to attain such a goal is bound to be a deterrent to developmental activities and cost prohibitive. Since the natural water bodies must be used for various competing as well as conflicting demands, the objective is then to restore and/or maintain natural water bodies or their parts to such a quality as needed for their best uses. Thus, a concept of “designated best use” (DBU) was developed. As per this concept, out of several uses a water body is put to, the use which demands highest quality of water is termed as “designated best use”, and accordingly the water body is designated. Primary water quality criteria for different uses have been identified. A summary of the use based classification system is given in **Table 3.20**. The stream classification of Ganga based on this is given in **Exhibit 12**.

Table 3.20 Designated Best Use Classification of Inland Surface Waters in India

S. No.	Designated Best Use	Class of Water	Criteria
1	Drinking Water Source without conventional treatment but after disinfection	A	1 Total Coliforms OrganismMPN/100ml shall be 50 or less 2 pH between 6.5 and 8.5 3 Dissolved Oxygen 6mg/l or more 4 Biochemical Oxygen Demand 5 days 20oC 2mg/l or less
2	Outdoor bathing (Organised)	B	1 Total Coliforms Organism MPN/100ml shall be 500 or less 2 pH between 6.5 and 8.5 3 Dissolved Oxygen 5mg/l or more 4 Biochemical Oxygen Demand 5 days 20oC 3mg/l or less
3	Drinking water source after conventional treatment and disinfection	C	1 Total Coliforms Organism MPN/100ml shall be 5000 or less 2 pH between 6 to 9 3 Dissolved Oxygen 4mg/l or more 4 Biochemical Oxygen Demand 5 days 20oC 3mg/l or less
4	Propagation of Wild life and Fisheries	D	1 pH between 6.5 to 8.5 2 Dissolved Oxygen 4mg/l or more 3 Free Ammonia (as N) 1.2 mg/l or less
5	Irrigation, Industrial Cooling, Controlled Waste disposal	E	1 pH between 6.0 to 8.5 2 Electrical Conductivity at 25oC micro mhos/cm Max.2250 3 Sodium absorption Ratio Max. 26 4 Boron Max. 2mg/l

Source: Central Pollution Control Board

3.10 CHANGE IN WATER QUALITY OF RIVER GANGA

1.52 Though a considerable investment has been made on the Ganga Action Plan (Phase I & II), the impact has been less than desired, although the water quality monitoring between 1986 and 2009 indicates some improvement in the water quality over pre-GAP period.

The water quality analysis of samples for parameters BOD and DO for 16 stations on River Ganga during 1986 and 2008 is given in **Table 3.21**. The results presented in **Table 3.21** shows improvement in Dissolved Oxygen (DO) levels at 4 locations namely up and down streams of Allahabad and Varanasi. All the 16 stations, except Patna downstream and Rajmahal show reduction in BOD values. The BOD level show marked reduction in Allahabad and Varanasi, indicating improvement in the water quality over pre-GAP period. However, at 7 of these 16 sites, the BOD level does not meet standard for bathing water. The situation is relatively better for DO, which fails to meet the bathing standard at only one site.

Table 3.21 WATER QUALITY DATA FOR RIVER GANGA
(Summer Average: March-June)

SUMMER AVERAGE VALUES FOR WATER QUALITY ON MAIN STEM OF RIVER GANGA UNDER GANGA ACTION PLAN																								
STATION NAME	**DISTANCE IN KM**	**DISSOLVED OXYGEN (DO) (mg/l) (Water Quality Standard for Bathing > 5 : Drinking > 6)**																						
		1986	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Rishikesh	0	8.1	8.1	7.6	6.2	7.1	6.8	8.5	9.0	9.6	9.0	8.9	8.9	9.3	9.0	9.1	8.2	9.2	8.4	8.5	8.3	8.2	8.1	8.0
Haridwar D/S	30	8.1	7.7	7.6	6.3	6.9	7.1	7.7	7.2	8.8	8.4	8.4	8.8	8.6	8.6	8.8	7.8	9.0	8.1	8.1	8.1	8.1	7.9	7.8
Garhmukteshwar	175	7.8	4.7	7.4	7.5	6.1	7.2	-	8.5	8.0	7.9	7.7	8.1	8.1	7.9	7.8	7.4	8.2	7.6	7.7	7.7	7.9	7.8	7.9
Kannauj U/S	430	7.2	7.7	6.9	7.5	7.1	7.3	7.7	7.2	8.8	8.0	8.0	7.8	7.4	7.1	7.4	7.6	7.9	7.0	8.5@	7.3	6.8	6.5	7.2
Kannauj D/S	433	NA	6.5	6.7	7.5	6.1	7.1	7.1	8.4	7.2	7.8	7.9	7.5	7.4	8.8	6.8	6.5	6.2	7.9	7.6@	6.5	6.4	6.2	7.6
Kanpur U/S	530	7.2	7.8	7.3	7.6	7.9	7.8	7.5	7.5	7.0	8.1	7.8	7.5	6.7	6.8	4.9	6.2	6.7	7.2	6.2@	6.2	5.8	4.9	7.5
Kanpur D/S	548	6.7	6.2	3.2	5.0	4.4	5.1	5.6	5.2	4.6	6.8	6.4	5.6	5.2	7.5	4.8	7.2	4.4	5.3	4.7@	3.9	4.6	6.0	7.5
Allahabad U/S	733	6.4	7.8	7.8	8.9	8.0	7.1	6.8	6.9	8.2	8.2	8.9	7.4	7.7	8.8	7.5	13.0	10.0	7.8	8.5&	7.1	7.9	8.4	8.1
Allahabad D/S	743	6.6	6.7	7.4	7.9	6.9	6.4	7.6	7.2	7.4	8.2	8.5	7.6	8.2	7.9	7.2	8.2	7.3	6.6	8.4&	8.5	8.8	7.7	8.1
Varanasi U/S	908	5.6	8.4	8.6	7.7	7.8	7.6	7.3	8.2	7.2	8.5	8.0	8.8	8.8	8.2	6.5	10.8	7.2	6.3	8.6&	8.7	8.1	7.5	7.8
Varanasi D/S	916	5.9	8.6	8.1	7.5	7.2	6.8	7.1	7.6	6.8	8.0	7.7	8.7	6.6	8.4	7.2	7.5	8.1	5.6	8.3&	8.7	8.4	7.3	7.7
Patna U/S	1188	8.4	8.5	7.9	8.0	7.7	8.1	8.1	8.2	7.0	6.8	7.3	7.5	7.0	7.7	7.8	7.0	7.5	6.6	7.4	7.4	7.1	6.0	7.0
Patna D/S	1198	8.1	8.7	7.5	8.1	7.5	7.4	8.0	8.0	7.2	6.9	7.0	7.1	7.2	7.8	7.7	7.1	7.8	6.7	8.0	8.1	6.9	5.9	6.8
Rajmahal	1508	7.8	8.1	7.7	8.0	7.8	7.5	8.1	8.5	7.6	7.6	7.3	7.2	6.9	7.5	7.7	7.9	7.5	6.9	7.4	7.2	7.4	6.2	6.5
Palta	2050	NA	7.3	6.5	7.2	6.8	7.3	7.4	7.1	6.8	6.7	6.6	6.5	7.3	NA	6.8	7.2	7.2	7.6	7.0	7.0	6.9	6.9	7.2
Uluberia	2500	NA	5.8	5.8	6.3	6.4	5.9	6.9	6.1	6.8	6.6	5.5	5.1	6.6	NA	-	5.4	5.6	6.3	5.4	5.5	6.8	5.3	5.4
STATION NAME	**DISTANCE IN KM**	**BIOCHEMICAL OXYGEN DEMAND (BOD) (Water Quality Standard for Bathing < 3 : Drinking < 2)**																						
		1986	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Rishikesh	0	1.7	2.8	3.4	1.8	1.5	1.1	1.2	1.3	2.0	1.5	1.0	1.1	1.1	1.0	1.1	1.2	0.5	1.1	1.0	1.1	1.2	1.2	1.0
Haridwar D/S	30	1.8	3.9	3.5	1.9	1.8	1.1	2.0	1.4	2.1	1.7	1.1	1.3	1.6	1.2	1.4	1.7	0.8	1.5	1.4	1.3	1.3	1.4	1.3
Garhmukteshwar	175	2.2	2.7	4.9	4.5	3.4	1.6	NA	1.6	2.5	2.4	1.5	1.5	1.8	1.4	1.8	2.2	1.2	1.9	2.0	2.1	2.0	1.9	2.0
Kannauj U/S	430	5.5	2.7	2.2	1.0	2.6	NA	2.1	2.3	2.7	2.4	2.9	3.4	3.6	5.3	14.4^	1.1	1.2	1.7	1.7@	1.1	1.7	2.9	1.5
Kannauj D/S	433	NA	5.1	5.6	1.1	3.0	3.0	2.7	2.5	3.0	3.2	3.2	3.7	3.5	4.8	11.8^	4.2	3.3	3.2	4.5@	4.2	4.1	3.1	4.8
Kanpur U/S	530	7.2	2.9	1.8	1.1	2.7	1.6	1.7	1.9	5.0	2.0	2.8	3.1	4.3	4.6	14.5^	3.8	3.7	3.2	4.3@	6.8	2.9	3.4	3.8
Kanpur D/S	548	8.6	9.7	13.4	3.5	3.5	65.8	25.0	24.5	8.5	5.5	4.1	5.4	6.4	6.5	18.5^	4.8	6.1	5.7	5.4	6.8	5.2	4.1	3.9
Allahabad U/S	733	11.4	7.0	2.8	2.6	2.6	2.3	2.0	1.8	2.3	4.5	2.5	3.3	4.3	1.8	5.3	8.0	4.8	7.38#	5.5&	4.9	7.5	4.8	6.3
Allahabad D/S	743	15.5	8.2	3.1	2.3	2.0	1.7	1.9	1.9	3.6	3.2	3.3	2.1	2.6	3.2	3.6	3.8	3.2	3.6	3.1&	3.2	4.1	3.2	4.0
Varanasi U/S	908	10.1	4.1	3.3	3.0	2.6	1.2	0.9	0.8	1.8	2.6	2.2	2.4	2.9	2.2	2.5	3.0	2.5	2.6	2.0&	2.1	2.3	2.2	3.8
Varanasi D/S	916	10.6	4.8	4.3	4.0	5.9	1.9	1.3	1.0	2.9	1.4	2.3	3.1	4.3	3.7	4.4	2.5	5.4	2.7	2.3&	2.3	3.7	3.0	3.1
Patna U/S	1188	2.0	1.9	2.0	0.4	0.3	1.4	1.2	1.2	1.6	1.5	2.0	2.0	1.2	1.9	1.9	1.8	2.0	1.6	2.0	2.0	1.7	1.7	1.6
Patna D/S	1198	2.2	2.1	2.2	0.4	0.3	0.9	1.6	1.5	1.6	1.4	1.6	1.3	1.6	2.4	2.4	1.9	2.8	1.7	2.2	2.3	1.8	2.4	2.1
Rajmahal	1508	1.8	1.6	2.0	0.2	0.3	1.0	0.6	0.7	1.9	1.7	1.3	1.4	1.1	1.5	1.5	1.4	2.2	2.1	1.8	2.0	1.6	2.0	1.6
Palta	2050	NA	1.0	1.3	1.0	0.9	0.8	1.0	0.9	2.5	2.1	1.6	2.1	2.2	NA	1.3	2.6	2.2	2.0	3.1	2.6	2.6	2.2	2.7
Uluberia	2500	NA	1.1	1.1	0.9	1.0	0.8	1.0	0.9	3.2	2.8	2.0	2.4	2.2	NA	-	1.9	1.9	2.4	2.6	2.6	3.2	3.6	2.4
* Mean value for the months of March to June when the temperatures are high and flows are low.																								
NA --> Date not available.																								
Water Quality carried out by: BHEL, Haridwar, IIT, Kanpur, CPCB, Zonal Office, Lucknow, Patna University, Patna, BCKV, West Bengal																								
Source: Central Pollution Control Board																								

The Fecal Coliform data monitored at 39 locations along Ganga for the period 2002 to 2008 is given in **Table 3.22**.

Table 3.22 Fecal Coliform Levels in River Ganga (Year 2002 -2008)

S. No.	State / Sampling Location	Fecal Coliform (MPN/100 TC)						
		2002	2003	2004	2005	2006	2007	2008
A	**UTTARAKHAND**							
1	Bhagirathi At Gangotri (BGR-GT)	40	40	120	84	NA	NA	NA
2	Mandakini B/C Alaknanda At Rudraprayag (MDK)	35	1050	1933	2800	980	8757	NA
3	Alaknanda A/C Mandakini At Rudraprayag (ALK-A/C)	79	620	3007	1600	90	3168	NA
4	Alaknanda B/C Mandakini At Rudraprayag (ALK-B/C)	61	1040	4053	6100	410	7993	NA
5	Bhagirathi B/C With Alaknanda At Devaprayag (BRG B/C)	149	4855	1287	4000	160	93	NA
6	Alaknanda A/C With Bhagirathi At Devaprayag (ALK–AC-BGR)	210	5500	1813	2050	140	453	NA
7	Alaknanda B/C To Bhagirathi At Devaprayag (ALK-BC-BGR)	468	1012	2207	3000	45000	2403	NA
8	Rishikesh U/S (RK-U/S)	115	108	11	NA	23	NA	1
9	Haridwar D/S (HDR-D/S)	400	260	18	19	19	23	3
10	Garhmukteshwar (GMW)	851	1062	14718	6011	5256	1724	1608
B	**UTTAR PRADESH**							
1	Narora (Bulandsahar) (NRR)	373	757	NA	1852	217	872	NA
2	Kannauj U/S (Rajghat) (KNJ-RG)	NA	919	994	4300	6243	2033	3490
3	Kannauj D/S (KNJ-D/S)	NA	1478	1191	5471	7314	3389	3267
4	Bithoor (Kanpur) (BTR-KN)	NA	1022	950	3611	4000	2150	3889
5	Kanpur U/S (Ranighat) (KN-U/S)	NA	1089	939	2813	3543	2633	3825
6	Kanpur D/S (Jajmau Pumping Station) (KN-D/S)	NA	4911	3464	26167	22857	32889	17333
7	Dalmau (Rai Bareilly) (DLU-RB)	4036	4589	4433	5117	3800	4833	4744
8	Allahabad (Rasoolabad) (ALB-RLD)	1202	1291	974	1417	2363	2950	2600
9	Allahabad D/S (Sangam) (ALB-SG)	1607	1626	1269	2292	7900	5150	5330
10	Varanasi U/S (Assighat) (VRS-U/S)	12417	9340	9333	10200	8977	10000	NA
11	Varanasi D/S (Malviya Bridge) (VRS-D/S)	148333	106300	103667	99333	89385	81714	NA
12	Trighat (Ghazipur) (TGT-GZ)	22583	17200	19750	22500	19500	20143	NA
C	**BIHAR & JHARKHAND**							
1	Buxar (BX)	2425	1263	3025	13356	18529	2933	4000
2	Khurji, Patna U/S (KRJ-P)	1589	882	1378	9322	11413	7000	4992
3	Patna D/S (Ganga Bridge) (PAT)	3019	1033	5056	13500	20171	10500	14545
4	Mokama (U/S) (MKA-U/S)	NA	NA	NA	15250	2980	6000	5245
5	Mokama (D/S) (MKA-D/S)	NA	NA	1533	9000	15200	9000	13917
6	Munger (MGR)	NA	NA	NA	13000	11233	5000	4225
7	Bhagalpur (BGR)	NA	NA	NA	17000	9800	5000	5800
8	Kahalgaon (KGN)	NA	NA	1167	16460	14500	9000	6100
9	Ganga at Rajmahal (RJM)	1480	1172	1696	NA	NA	NA	NA
D	**WEST BENGAL**							
1	Baharampore (BRP)	30917	7667	7917	17004	23833	33667	29000
2	Serampore (SRP)	471250	170000	243333	53003	38000	76750	63000
3	Dakshineshwar (DSW 1)	230417	406667	260417	351667	123571	237917	283333
4	Howrah-Shivpur (HWH SP)	48750	91667	187500	96250	231667	140000	100000
5	Garden Reach (GRWB)	101250	271667	295000	86250	406667	382500	176250
6	Uluberia (UWB)	50333	84250	106167	62083	45571	37917	37000
7	Palta (PTWB)	99545	35250	40917	52333	63333	75455	67500
8	Diamond Harbour (DHWB)	2200	5400	30333	7000	11667	23000	11250

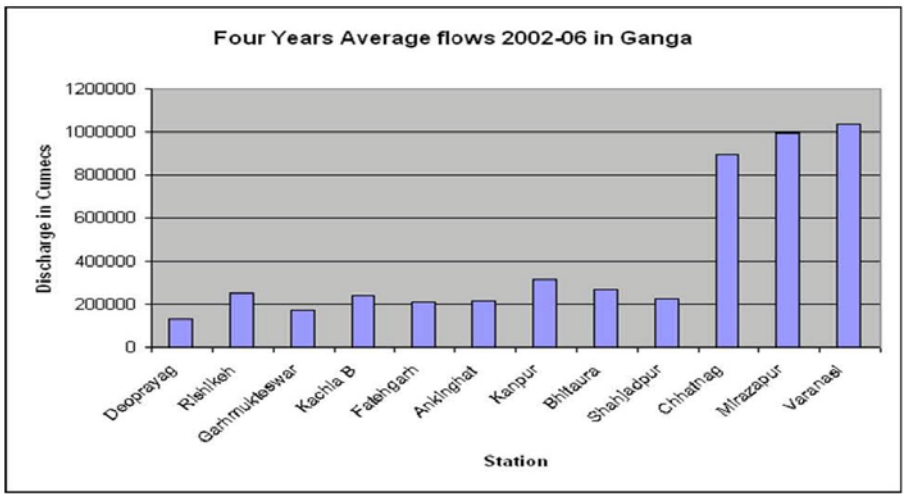
Source: Central Pollution Control Board

As can be seen from **Table 3.22**, the Faecal Coliform (FC) count at Varanasi (downstream of Malvia bridge), Uttar Pradesh reached the high level of 148333 MPN/100 ml in 2002 and declined to a count of 81714 MPN/100ml in

2007, thus showing a very strong decreasing trend especially when compared to the laid down standards of <500 MPN/100ml for bathing. Among the 12 sampling stations in Uttar Pradesh, all show an increased count of FC in year 2007-2008 over year 2002. Of the 10 stations in Uttarakhand, only at Rishikesh and Haridwar has the FC count consistently been at acceptable level for bathing. At other sites, it fluctuates and accepting at Devprayag exceeded bathing standard. In Bihar, the minimum and maximum count of FC taken in 2008 ranged from 4000 MPN/100ml to 14545 MPN/100ml respectively. In West Bengal, the FC count shows higher values in all the stations with a minimum of 11250 MPN/100ml and a maximum of 283333 MPN/100ml in 2008 in 8 stations sampled against the laid down standards of <500 MPN/100ml for bathing. However, FC count exceeds acceptable standards at major locations. Without the Ganga Action Plan and the increasing population trend, the situation would have been even worse. The water quality status of rivers within Ganga basin is given in **Exhibit 13**.

An important factor is inadequate river flow due to water extraction for various purposes including irrigation, drinking water supply and industrial use. Significant quantities of Ganga water is extracted into the Upper and Lower Ganga canals resulting in meager flows, especially, the Haridwar-Allahabad stretch, which has become very critical.

A chart showing discharge in cumecs at various stations on Ganga between Devaprayag and Varanasi during 2002-2006 is given hereunder.



Water Abstraction from River Ganga

Source: Central Pollution Control Board

3.11 GANGA ACTION PLAN (Phase I & II)

153. The Govt. of India (GOI) launched the Ganga Action Plan (GAP) in the year 1985, with an ambitious objective of abatement of pollution in River Ganga due to discharge of untreated sewage into the river from point as well as non-point sources and thus to improve the water quality in River Ganga.

The approach of the GAP was to create sewage treatment plants in the cities along the Ganga so that no untreated sewage is discharged into the river. This was expected to bring the quality of the river water to a desired level.

The program of river cleaning was extended to other major rivers of the country under two separate schemes namely Ganga Action Plan (Phase II) and the National River Conservation Plan (NRCP).

The Ganga Action Plan and the subsequent NRCP program (launched in 1995), which included Ganga Action Plan Phase II for cleanup of rivers, covered altogether 167 towns in 20 states and 38 rivers across India. A total of 1085 schemes with an estimated project cost of Rs. 470 million, aimed at pollution abatement of rivers and improvement of water quality has been approved, out of which 802 schemes has been completed, with an expenditure of Rs. 352 million.

The estimated sewage generation / projections, treatment capacity created and/or proposed to be created under different schemes in these six major cities of GAP states are given in **Tables 3.23 and 3.24**.

Under the Ganga Action Plan (Phase I & II), the target was to install a cumulative sewage treatment plant capacity of 1198 MLD, out of which 1016 MLD has been installed in the five states namely Bihar, Jharkhand, Uttar Pradesh, West Bengal and Uttarakhand (GAP States).

Table 3.23 Target and STP Capacities installed under Ganga Action Plan						
S. No.	State	Phase	STP Created (MLD)		Cost (Rs. Lakh)	
			Target	Actuals	Actual	Completion Cost
1	Bihar	GAP I	111	111	1467.18	1420.38
		GAP II	24.5	11	434.44	184.7
2	Jharkhand	GAP I	–	–	–	–
		GAP II	–	–	–	–
3	Uttar Pradesh	GAP I	349.5	349.5	9367.6	9701.35
		GAP II	80.67	35.56	2536.28	2079.7
4	West Bengal	GAP I	376.6	372.6	7179.99	6913.79
		GAP II	117.34	108.47	2435.25	1584.36
5	Uttarakhand	GAP I	24.33	24.33	857.6	921.88
		GAP II	13.95	4.17	473.49	27.06
	Total		**1097.89**	**1016.63**	**24751.83**	**22833.22**
Source:						

Table 3.24 Sewage Generation for Various Years, Treatment Capacity Created / Proposed to be Created in Six Selected Towns of GAP-I									
S. No.	State	City / Town	Sewage Generation (MLD)				Treatment Capacity Created so far Under GAP I & II (MLD)	Treatment Capacity Being Created Under GAP II (MLD)	Treatment Capacity Under JNNURM (MLD)
			1985	2008	2010*	2020*			
1	Uttarakhand	Rishikesh, Haridwar	24.33	65	75	94	28.5	43	–
2	Uttar Pradesh	Kanpur	205	400	411	555	171	–	268 (Sanctioned)
3	Uttar Pradesh	Allahabad	110	210	213	242	89	–	60 (Projects under consideration of MoUD)
4	Uttar Pradesh	Varanasi	147	292	317	350	101.8	37	120 (Sanctioned)
5	Bihar	Patna	100	210	236	316	109	–	246 (Projects under preparation)
6	West Bengal	Howrah	75	111	121	142	85	–	–
	Total		**661.33**	**1288**	**1373**	**1699**	**584.3**	**80**	**694**
* Projected									
Source:									

It can be seen from **Table 3.23** 2900 out of the total 1098 mld treatment capacity, the STP capacity in these six cities is 664 MLD, which constitute only 52% of the total needed capacity as of 2008 and therefore grossly inadequate to treat the sewage generated. Even if all the projects considered under Jawaharlal Nehru National Urban Renewal Mission (JNNURM) become operational by 2010 – a very unlikely prospect – the STP capacity created would still be inadequate to meet the needs of these states beyond 2010 and therefore these cities will continue to discharge untreated sewage in River Ganga.

SECTION 4
INITITATIVES OF GOI

4.1 BACKGROUND ON NGRBA

154. As mentioned in Section one, the Government of India, has constituted the National Ganga River Basin Authority (NGRBA) for comprehensive management of the Ganga River under section 3(3) of the Environment Protection Act, 1986. The Ministry of Environmental and Forests (MoEF) has been designated as the nodal agency for this program. The NGRBA will adopt a river-basin approach and has a multi-sector mandate to address both water quantity and quality aspects of Ganga. At the state level, State Ganga River Basin Authorities (SGRBA's) have been proposed and four states (Uttar Pradesh, West Bengal, Jharkhand and Bihar) have already established such bodies..

4.2 PORTFOLIO OF PROJECTS

155. The portfolio of river pollution mitigation projects to be implemented under the National Ganga River Basin Project (NGRBP) is given in **Table 4.1**. The implementation of these projects is spread across several cities and/or towns within the Ganga basin states of Uttarakhand, Uttar Pradesh, Bihar, Jharkhand and West Bengal.

Table 4.1 Portfolio of River Pollution Mitigation Projects under NGRBP

S.No.	Portfolio of Projects	Portfolio Components
1	Sewerage and Sanitation Schemes	• Provision for an entirely new sewerage network including individual house connections and gravity based interception and diversion arrangements to drains carrying sanitary sullage/dry weather flow • Extensions to existing sewerage networks in some parts of cities/towns to include areas which are un-sewered hitherto or to newly developed areas in the recent years
2	Sewage Treatment Plants/Facility	• Entirely new sewage treatment plant/facility • Augmentation of capacities in existing sewage treatment plant/facility • Remodelling /Renovation of existing sewage treatment facilities, resulting in better effluent quality and augmented treatment capacity
3	Solid Waste Treatment Facilities	• Engineered landfills with leachate collection and treatment systems • Waste segregation and composting facilities
4	Industrial Pollution Control Facilities	• Common Industrial Effluent Treatment Plants(CETP's) • Hazardous Waste Treatment, Storage and Disposal Facility(TSDF's) • Other Industrial Effluent Treatment and disposal facility
5	River Front Development Schemes	• River Front Development and beautification schemes of river banks • Construction of Bathing Ghats • Redevelopment of Cremation grounds, situated on river banks • Development of electric and or gas based crematoriums situated on river banks
To be implemented within the Ganga basin states of Uttarakhand, Uttar Pradesh, Bihar, Jharkhand and West Bengal		

The portfolio of projects under the NGRBP mainly aims at preventing discharge of untreated sewage into River Ganga and thus aiding abatement of river water pollution and improvement in water quality. Consequently, this also contributes to an improvement in the status of environment, health &

sanitation for the citizens of the concerned cities and towns. The projects, which will be implemented under NGRBP, have their own beneficial impacts, as well as potential some adverse. The significance of these impacts depends on the individual project, along with its size and location. In general, the projects under NGRBP are small in size as compared to major infrastructure development projects and/or Industrial projects and therefore relatively have less potential adverse impacts.

4.3 POTENTIAL ENVIRONMENTAL IMPACTS OF PROJECTS

156. The implementation of the river pollution mitigation projects under the National Ganga River Basin Project (NGRBP) is anticipated to encounter a variety of environmental and social issues/problems, including: the pollution of surface and groundwater bodies or other natural resources; issues related to air pollution or other environmental health and sanitation problems; inconvenience to public due to traffic diversions and construction activities; and, issues of land acquisition and rehabilitation and resettlement. The NGRBP recognize these environmental and social issues and plans to mitigate them through a set of management procedures detailed in this Environmental & Social Management Framework (ESMF). NGRBA, through its state level SGRBA's will ensure that policies and procedures described in the ESMF are applied to all World Bank supported projects.

157. To develop and guide its environmental and social management procedures, the NGRBA has carefully examined the portfolio of projects previously executed under the river pollution mitigation projects under Ganga Action Plan (Phase I and II), along with similar other urban infrastructure projects implemented elsewhere in the country under various Government of India sponsored schemes. It has supplemented these studies with field visits and appraisals of sample projects to be implemented under the present NGRBP and accordingly identified the environment and social issues arising from projects, to be implemented under NGRBP.

Appendix 1

Monthly Stream Flow (cum / second) in the Ganga at 90, 50 and 10 percentile levels									
S. No.	**Month**	**90 percentile flow**	**50 percentile flow**	**10 percentile flow**	**Mean Flow**	**90 percentile flow**	**50 percentile flow**	**10 percentile flow**	**Mean Flow**
		Rishikesh (1971 - 1981)				**Balawali (1976 - 1981)**			
1	January	141	165	171	160	5	11	45	19
2	February	138	159	180	155	4	7	82	22
3	March	135	174	216	187	4	9	231	58
4	April	170	239	306	246	3	45	115	44
5	May	241	404	494	381	57	150	460	183
6	June	496	827	1497	997	262	486	1017	557
7	July	1950	2794	2921	2610	968	1515	1995	1525
8	August	2146	3180	3619	3159	1316	1932	3898	1955
9	September	130	1418	2132	1387	457	1023	1510	980
10	October	335	433	535	460	75	292	488	293
11	November	190	256	300	263	9	66	97	63
12	December	149	190	211	188	5	8	62	23
		Kanpur (1960 - 1981)				**Allahabad (1970 - 1981)**			
1	January	84	166	274	177	358	458	688	515
2	February	75	142	308	183	266	385	591	458
3	March	62	120	274	151	224	294	581	419
4	April	48	101	166	106	184	288	550	359
5	May	45	71	155	86	157	332	470	349
6	June	67	199	636	311	245	474	1097	805
7	July	1186	1983	3262	2127	1995	7400	10439	7470
8	August	2310	4158	6317	4456	6183	19693	21674	18224
9	September	977	3648	4994	4755	2696	15768	24131	15949
10	October	329	1050	1802	1140	849	3052	4699	2985
11	November	152	374	639	419	436	1125	1510	1044
12	December	106	222	322	224	463	598	737	620
		Varanasi (1960 - 1981)				**Patna (1965 - 1981)**			
1	January	297	480	731	500	860	1321	1683	1335
2	February	275	443	783	490	540	1186	1437	1152
3	March	226	343	722	416	579	1019	1414	1041
4	April	183	304	513	353	677	932	1399	997
5	May	177	255	361	285	609	1065	1582	1108
6	June	186	300	617	422	976	1595	3167	2043
7	July	2500	5070	8893	5519	4749	11011	19356	12458
8	August	5777	13324	21262	13454	13536	27992	37424	24751
9	September	3018	13763	20025	12459	7835	21817	34673	33823
10	October	952	2666	4797	3107	3493	6611	12163	7911
11	November	421	1187	1579	1127	1100	2705	4666	2816
12	December	316	619	820	630	1083	1691	2365	1747
		Azamabad (1960 - 1981)				**Nabadwip (Purbasthali - 1975 - 1981)**			
1	January	1551	2154	2612	2126	922	1026	1188	1048
2	February	1180	1902	2356	1841	438	1021	1163	957
3	March	897	1513	2114	1542	393	875	1063	838
4	April	1060	1352	2036	1469	350	884	1081	829
5	May	1139	1613	2173	1694	596	1105	1159	1013

6	June	1619	2915	4239	3273	1123	1266	1402	1263
7	July	4597	13757	21883	15048	1392	1824	2237	1817
8	August	19558	33493	49968	37044	1663	1980	2235	2000
9	September	14396	35830	44962	33700	1380	2120	2600	1995
10	October	4390	10434	24424	15453	1428	1519	2407	1734
11	November	2683	4899	8100	5056	927	1055	1132	1041
12	December	2071	2791	3765	2904	1106	1221	1293	1203

Source : Central Water Commission

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Appendix 2

Mean Daily Air Temperature (1951-80), Mean Monthly Rainfall (1951-80) and Mean Monthly Evaporation (1959-75) at Selected Stations

S. No.	Month	Mean daily air temperature (°C)		Rain fall	Evaporation	Mean daily air temperature (°C)		Rain fall	Evaporation
		Min.	Max.	(mm)	(mm)	Min.	Max.	(mm)	(mm)
		Dehra Dun				**Delhi (Safdarjang)**			
1	Jan	5.8	19.4	51.6	43.4	7.3	21.1	20.3	71.3
2	Feb	7.9	21.9	48.1	64.4	10.1	24.2	15.0	100.8
3	Mar	12.2	26.7	51.3	114.7	15.4	30.0	15.8	176.7
4	Apr	16.9	32.3	17.3	183.0	21.5	36.2	6.7	300.0
5	May	20.5	35.8	36.2	229.4	25.9	39.6	17.5	399.9
6	Jun	23.0	34.9	225.0	183.0	28.3	39.3	54.9	333.0
7	Jul	22.5	30.5	718.6	102.3	26.6	35.1	231.5	232.5
8	Aug	22.0	29.5	734.0	93.0	25.9	33.3	258.7	134.3
9	Sep	20.6	29.7	321.7	90.0	24.4	33.9	127.8	147.0
10	Oct	15.9	28.5	47.5	83.7	19.5	32.9	36.3	148.8
11	Nov	10.4	25.1	11.3	58.9	12.8	28.3	5.0	102.0
12	Dec	6.8	21.3	23.2	43.4	8.2	23.0	7.8	77.5
	Total			**2315.4**	**1289.2**			**797.3**	**2223.8**
		Hissar				**Kota**			
1	Jan	5.5	21.4	13.4	77.5	9.7	23.8	2.0	114.7
2	Feb	8.3	24.7	15.5	109.2	13.1	27.4	3.4	151.2
3	Mar	13.7	30.5	12.1	192.2	18.3	33.3	4.3	248.0
4	Apr	19.4	36.8	5.6	327.0	24.5	38.8	1.1	357.0
5	May	24.2	40.7	20.3	418.5	29.0	42.3	12.2	449.5
6	Jun	27.7	41.0	42.9	399.0	28.7	39.9	84.3	378.0
7	Jul	27.0	37.0	140.7	279.0	26.1	34.1	285.1	213.9
8	Aug	26.0	35.1	146.9	198.4	25.0	31.7	276.3	139.5
9	Sep	23.7	35.4	65.0	207.0	24.4	33.8	126.0	150.0
10	Oct	17.8	34.3	14.8	179.8	21.1	34.6	18.6	170.5
11	Nov	11.0	29.1	6.1	114.0	15.4	30.3	15.6	123.0
12	Dec	6.5	23.5	7.3	77.5	11.2	25.2	4.4	96.1
	Total			**490.6**	**2579.1**			**843.4**	**2591.4**
		Gaya				**Kolkata {Alipore)**			
1	Jan	9.2	23.7	19.0	96.1	13.9	26.6	16.8	74.4
2	Feb	11.8	27.2	12.3	131.6	16.9	29.7	22.9	92.4
3	Mar	16.9	33.5	9.8	235.6	21.7	34.0	32.8	148.8
4	Apr	22.9	39.3	8.9	345.0	25.1	36.3	47.7	186.0
5	May	26.7	41.2	16.2	384.4	26.4	36.0	101.7	204.6
6	Jun	27.7	38.2	137.6	282.0	26.5	34.1	259.9	150.0
7	Jul	26.2	33.4	293.1	164.3	26.1	32.2	331.8	127.0
8	Aug	25.9	32.5	290.4	139.5	26.1	32.0	328.8	117.0
9	Sep	25.2	32.5	218.6	135.0	25.8	32.2	295.9	108.0
10	Oct	21.5	31.7	60.5	117.8	24.0	31.9	151.3	105.4
11	Nov	14.2	28.8	5.4	102.0	18.9	29.8	17.2	87.0
12	Dec	9.6	24.8	3.2	86.8	14.3	27.0	7.4	71.3
	Total			**1075.0**	**2220.1**			**1641.4**	**1471.9**
		Allahabad				**Patna**			

1	Jan	8.7	23.6	19.2	71.3	9.2	23.3	18.9	74.4
2	Feb	11.2	27.2	15.6	98.0	11.6	26.5	10.7	109.2
3	Mar	16.5	33.6	9.2	176.7	16.4	32.6	11.4	207.7
4	Apr	22.5	39.4	5.7	258.0	22.3	37.7	7.6	285.0
5	May	26.7	42.3	9.9	303.8	25.2	38.9	33.3	285.2
6	Jun	28.5	40.1	85.4	267.0	26.7	36.7	134.2	237.0
7	Jul	26.4	34.1	300.1	155.0	26.2	33.0	305.8	170.5
8	Aug	25.7	32.7	307.6	120.9	26.1	32.4	274.4	136.4
9	Sep	24.7	33.2	189.8	120.0	25.4	32.3	226.9	123.0
10	Oct	20.5	33.1	40.1	114.7	21.8	31.5	93.8	108.5
11	Nov	13.8	29.7	11.7	90.0	14.7	28.8	8.9	81.0
12	Dec	9.3	24.8	3.4	68.2	9.9	24.7	4.1	68.2
	Total			**1017.7**	**1843.6**			**1003.4**	**1886.1**

Source: India Meteorological Department

Appendix 3

Biosphere Reserves of India						
S. No.	**Year**	**Name**	**Location**	**State**	**Type**	**Area (SqKm)**
1	2008	Rann of Kuchch / Gyan Bharati Reserve	Part of Kuchch, Rajkot and Surendranagar District	Gujarat	Desert	12454
2	1989	Gulf of Mannar*	Indian part of Gulf of Mannar between India and Sri Lanka	Tamil Nadu	Coasts	10500
3	1989	Sunderbans*	Part of Delta of Ganges and Barahamaputra River System	West Bengal	Gangetic Delta	9630
4	1988	Nanda Devi*	Parts of Chamoli District, Pithoragarh District and Almora District	Uttarakhand	West Himalayas	5860.69
5	1986	Nilgiri Biosphere Reserve*	Part of Wynad, Nagarhole, Bandipur and Mudumalai, Nilambur, Silent Valley and Siruvani Hills	Tamil Nadu, Kerala and Karnataka	Western Ghats	5520
6	1998	Dehang Deband	Part of Siang and Debang Valley	Arunachal Pradesh	East Himalayas	5112
7	1999	Pachmarhi Biosphere Reserve*	Parts of Betul District, Hoshangabad District and Chhindwara District	Madhya Pradesh	Semi-Arid	4926
8	1994	Simlipal*	Part of Mayurbhanj District	Orissa	Deccan Peninsula	4374
9	2005	Achanakamar - Amarkantak	Part of Annupur, Dindori and Bilaspur Districts	Madhya Pradesh, Chattisgarh	Maikala Range	3835
10	1989	Manas	Part of Kokrajhar, Bongaigaon, Barpeta, Nalbari, Kamrup and Darrang District	Assam	East Himalayas	2837
11	2000	Kanchanjunga	Parts of Kanchanjunga Hills	Sikkim	East Himalayas	2619.92
12	2001	Agasthyamalai Biosphere Reserve	Parts of Thirunelveli and Kanyakumari District in Tamil Nadu and Thiruvanthapuram,	Kerala and Tamil Nadu	Western Ghats	3500.36

			Kollam and Pathanmthitta in Kerala			
13	1989	Great Nicobar Biosphere Reserve	Southern most islands of Andaman and Nicobar Islands	Andaman and Nicobar Islands	Islands	885
14	1988	Nokrek*	Part of Garo Hills	Meghalaya	East Himalayas	820
15	1997	Dibru - Saikhowa	Part of Dibrugarh District and Tinsukia District	Assam	East Himalayas	765
* Also a part of World Network of Biosphere Reserves, based on the UNESCO main & Biosphere (MAB) programme list						

Source: Environmental Atlas of India, MoEF

Appendix 4

Wildlife Sanctuaries located in the entire Ganga Basin (Statewise)				
S. No.	**Year**	**Name**	**State**	**Area (SqKm)**
1	1978	Kaimur	Bihar	1342.22
2	1976	Bhimbandh	Bihar	681.90
3	1978	Valmikinagar	Bihar	461.60
4	1976	Gautam Buddha	Bihar	259.48
5	1978	Lawalang	Bihar	211.03
6	1985	Nakti Dam	Bihar	206.40
7	1986	Kabar	Bihar	204.00
8	1976	Mahuadaur	Bihar	63.25
9	1984	Parasnath	Bihar	49.23
10	1978	Rajgir	Bihar	35.84
11	ND	Chandra Prabha	Bihar	ND
12	ND	Topchanchi	Bihar	ND
13	ND	Indira Priyadarshini	Delhi	13.20
14	1987	Chautala	Haryana	113.96
15	1975	Bir Shikargarh	Haryana	10.93
16	1962	Sechu Tuan Nala	Himachal Pradesh	655.32
17	1962	Tundah	Himachal Pradesh	419.48
18	1982	Rupi Bhabha	Himachal Pradesh	354.14
19	1962	Kugti	Himachal Pradesh	330.00
20	1983	Pong Dam Sanctuary	Himachal Pradesh	322.70
21	1962	Nargu	Himachal Pradesh	243.13
22	1962	Bandli	Himachal Pradesh	239.47
23	1962	Gobind Sagar & Naina Devi	Himachal Pradesh	120.67
24	1976	Chail	Himachal Pradesh	110.04
25	1949	Gamgul Siahbehi	Himachal Pradesh	105.46
26	1962	Darlaghat	Himachal Pradesh	98.71
27	1962	Shikari Devi	Himachal Pradesh	71.19
28	1976	Tirthan	Himachal Pradesh	68.25
29	1954	Kanawar	Himachal Pradesh	61.57
30	1985	Churdhar	Himachal Pradesh	56.59
31	1962	Raksham Chitkul	Himachal Pradesh	38.27
32	1962	Naina Devi	Himachal Pradesh	37.19

33	1962	Talra	Himachal Pradesh	36.16
34	1962	Majathal	Himachal Pradesh	31.64
35	1954	Manali	Himachal Pradesh	31.27
36	1949	Kalatop & Khajjiar	Himachal Pradesh	30.69
37	1962	Lippa Asrang	Himachal Pradesh	29.53
38	1962	Daranghati	Himachal Pradesh	27.01
39	1954	Khokhan	Himachal Pradesh	17.60
40	1958	Simbalbara	Himachal Pradesh	17.20
41	1954	Kais	Himachal Pradesh	12.20
42	ND	Renuka	Himachal Pradesh	ND
43	ND	Shilli	Himachal Pradesh	ND
44	1976	Palamau	Jharkhand	767.00
45	1976	Dalma	Jharkhand	193.22
46	1976	Hazaribagh	Jharkhand	186.25
47	1985	Koderma	Jharkhand	177.95
48	1975	Noradehi	Madhya Pradesh	1034.52
49	1976	Ratapani	Madhya Pradesh	688.79
50	1978	Tamor Pingla	Madhya Pradesh	608.52
51	1974	Sitanadi	Madhya Pradesh	553.36
52	1975	Achanakmar	Madhya Pradesh	551.55
53	1977	Bori	Madhya Pradesh	518.25
54	1981	Ghatigaon	Madhya Pradesh	512.00
55	1978	Bagdogra	Madhya Pradesh	478.90
56	1977	Pachmarhi	Madhya Pradesh	461.85
57	1974	Gandhi Sagar	Madhya Pradesh	368.62
58	1975	Sanjay (Dubri)	Madhya Pradesh	364.69
59	1983	Sardarpur Florican	Madhya Pradesh	348.12
60	ND	Kuno - Palpur	Madhya Pradesh	345.00
61	1981	Palpur - Kuno Wildlife Sanctuary	Madhya Pradesh	344.68
62	1978	Samarsot	Madhya Pradesh	340.35
63	1978	National Chambal	Madhya Pradesh	320.00
64	1976	Singhori (Sindhari)	Madhya Pradesh	287.91
65	1972	Gomardah	Madhya Pradesh	277.82
66	1983	Pamed Wild Buffalo	Madhya Pradesh	262.00
67	1983	Udanti Wild Buffalo	Madhya Pradesh	247.59
68	1983	Panpatha	Madhya Pradesh	245.84
69	1976	Barnawapra	Madhya Pradesh	244.66
70	1981	Karera	Madhya Pradesh	202.21
71	1983	Bhairamgarh	Madhya Pradesh	138.95
72	ND	Kheoni	Madhya Pradesh	122.70
73	1983	Fensatallite	Madhya Pradesh	110.24
74	1975	Badankhoh	Madhya Pradesh	104.35
75	1974	Narsingarh	Madhya Pradesh	57.19

76	1981	Ken Gharial	Madhya Pradesh	45.00
77	1981	Sone Gharial	Madhya Pradesh	41.80
78	1983	Sailana Florican	Madhya Pradesh	12.96
79	1983	Keladevi	Rajasthan	676.00
80	1971	Kumbhalgarh	Rajasthan	578.26
81	1983	Phulwari	Rajasthan	511.41
82	1983	Todgarh Raoli	Rajasthan	495.27
83	1979	Sita Mata	Rajasthan	422.94
84	1982	Ramgarh Bundi	Rajasthan	307.00
85	1982	Jamwa Ramgarh	Rajasthan	300.00
86	1960	Mountabu	Rajasthan	288.84
87	1983	National Chambal	Rajasthan	280.00
88	1955	Darah	Rajasthan	265.83
89	1983	Bhensrodgarh	Rajasthan	229.14
90	1985	Baretha	Rajasthan	192.76
91	ND	Sundha Mata	Rajasthan	107.00
92	1984	Sawai Mansingh	Rajasthan	103.25
93	1980	Jawahar Sagar	Rajasthan	100.00
94	1983	Shergarh	Rajasthan	98.71
95	1955	Van Vihar	Rajasthan	59.93
96	1956	Jaisamand	Rajasthan	52.00
97	1980	Nahargarh	Rajasthan	50.00
98	ND	Tal Chappar	Rajasthan	ND
99	ND	Bassi	Rajasthan	ND
100	ND	National Garhial	Rajasthan	ND
101	1979	National Chambal	Uttar Pradesh	635.00
102	1982	Kaimoor	Uttar Pradesh	500.75
103	1954	Govind Pashu Vihar	Uttar Pradesh	481.04
104	1987	Sohagabarwa	Uttar Pradesh	428.20
105	1976	Kateraniaghat	Uttar Pradesh	400.09
106	1987	Sonanandi	Uttar Pradesh	301.18
107	1977	Ranipur	Uttar Pradesh	230.31
108	1972	Kishanpur	Uttar Pradesh	227.12
109	1957	Chandra Prabha	Uttar Pradesh	78.00
110	1986	Hastinapur	Uttar Pradesh	20.73
111	ND	Asan Bradge Bird Watching	Uttar Pradesh	ND
112	ND	Chilla	Uttar Pradesh	ND
113	ND	Mahavir Swamy	Uttar Pradesh	ND
114	ND	Nawabganj	Uttar Pradesh	ND
115	ND	Samaspur	Uttar Pradesh	ND
116	1972	Kedarnath	Uttarakhand	975.24
117	1988	Binsar	Uttarakhand	45.59
118	1976	Singhalila	West Bengal	362.40
119	1986	Buxa	West Bengal	251.89
120	1990	Jaldapara	West Bengal	216.51
121	1976	Murti Wildlife	West Bengal	127.22
122	1976	Senchal	West Bengal	38.88
123	1976	Lothian Island	West Bengal	38.00
124	1976	Halliday Island	West Bengal	5.95
125	ND	Bibnutibhushan	West Bengal	ND
126	ND	Betuadahary	West Bengal	ND
127	ND	Ballavpur	West Bengal	ND
128	ND	Chapramari	West Bengal	ND

129	ND	Gorumara	West Bengal	ND
130	ND	Jorpokhri	West Bengal	ND
131	ND	Mahananda	West Bengal	ND
132	ND	Parnadhan	West Bengal	ND
133	ND	Ramnabagan	West Bengal	ND
134	ND	Raiganj	West Bengal	ND

Appendix 5

Urban centres and waste water generation, treatment and mode of disposal in class I cities

Disposal In River Ganga

S.NO	City/Town	State/UT	Population	Total Sewage (in MLD)	Treatment Capacity (in MLD)	Percentage covered	Treated sewage Disposal
1	Bhagalpur	Bihar	381190	61.6	11	18%	Ganga river basin
2	Patna	Bihar	1542184	249.2	109	44%	Ganga river basin
3	Munger	Bihar	209790	34	13.5	40%	Ganga river basin
4	Katihar	Bihar	196190	31.7	31.7	100%	Ganga river basin
5	Kanpur	Uttar Pradesh	3114530	339.3	171.1	50%	Ganga river basin
6	Varanasi	Uttar Pradesh	1353920	187.1	141	75%	Ganga river basin
7	Allahabad	Uttar Pradesh	1218070	208	89	43%	Ganga river basin
8	Farrukhabad-cum-Fatehgarh	Uttar Pradesh	280290	30.5	8.3	27%	Ganga river basin
9	Mirzapur-Vindhyachal	Uttar Pradesh	252470	27.5	14	51%	Ganga river basin
10	Unnao	Uttar Pradesh	178250	23.9	19.4	81%	Ganga river basin
11	Ballia	Uttar Pradesh	125740	18	-	0%	Ganga river basin
12	Dehradun	Uttarakhand	550800	76.1	-	0%	Ganga river basin
13	Hardwar	Uttarakhand	215260	39.6	18	45%	Ganga river basin
14	Kolkata	West Bengal	5267630	618.4	172	28%	Ganga river basin
15	Haldia	West Bengal	196300	24.5	24.5	100%	Ganga river basin

16	Santipur	West Bengal	158920	18.7	18.7	100%	Ganga river basin
17	Nabadwip	West Bengal	132290	15.5	10	65%	Ganga river basin
18	Basirhat	West Bengal	130090	15.3	-	0%	Ganga river basin
19	Bangaon	West Bengal	117430	13.8	-	0%	Ganga river basin
20	South Dumdum	West Bengal	450970	53	52.9	100%	Ganga river basin
21	Rajpur Sonarpur	West Bengal	386850	33.6	45.4	100%	Ganga river basin
22	Kamarhati	West Bengal	361480	48.8	40	82%	Ganga river basin
23	North Dumdum	West Bengal	253040	29.7	-	0%	Ganga river basin
24	Naihati	West Bengal	247750	20.5	-	0%	Ganga river basin
25	Ulberia	West Bengal	232410	27.3	-	0%	Ganga river basin
26	Kanchrapara	West Bengal	145040	17	-	0%	Ganga river basin
27	Halisahar	West Bengal	143150	16.8	-	0%	Ganga river basin
28	North Barrackpur	West Bengal	142050	19.2	16.7	87%	Ganga river basin
29	Rishra	West Bengal	130250	13.5	15.3	100%	Ganga river basin
30	Ashoknagar Kalyangarh	West Bengal	128200	17.3	15	87%	Ganga river basin
31	Haora	West Bengal	1160010	136.2	63.9	47%	Ganga river basin
32	Bhatpara	West Bengal	508250	59.7	28.5	48%	Ganga river basin
33	Maheshtala	West Bengal	447600	52.5	3.9	7%	Ganga river basin
34	Serampore	West Bengal	227650	26.7	18.9	71%	Ganga river basin
35	Chandannagar	West Bengal	186490	16.1	22.7	100%	Ganga river basin

36	Habra	West Bengal	146850	17.2	-	0%	Ganga river basin
	Total		2,09,19,384	2637.7	1174		

Disposal In tributaries

S.NO	City/Town	State/UT	Population	Total Sewage (in MLD)	Treatment Capacity (in MLD)	Percentage covered	Treated sewage Disposal
1	Muzaffarpur	Bihar	342120	55.3	-	0	Budhi Gandak
2	Bihar Sharif	Bihar	259810	42	-	0	Phalgun
3	Gaya	Bihar	429180	69.4	-	0	Phalgun
4	Bettiah	Bihar	130700	21.1	-	0	Budhi Gandak
5	Motihari	Bihar	113690	18.4	-	0	Budhi Gandak
6	Hajipur	Bihar	133590	21.6	-	0	Gandak
7	Darbhanga	Bihar	298850	48.3	-	0	Ghughri
8	Chapra	Bihar	200300	32.4	2	0.0617	Ghaghara
9	Sasaram	Bihar	146770	23.7	-	0	Chandrabhaga
10	Siwan	Bihar	121150	19.6	-	0	Daha
11	Arrah	Bihar	227800	36.8	-	0	Son
12	Dehri	Bihar	133290	21.5	-	0	Son
13	Saharsa	Bihar	138900	22.4	-	0	Simrahi Stream
14	Yamunanagar	Haryana	250250	18.6	35	1	WJC
15	Bokaro	Jharkhand	484830	71.3	-	0	Damodar
16	Dhanbad	Jharkhand	1064357	36	-	0	Damodar
17	Hazaribagh	Jharkhand	156510	23	-	0	Damodar
18	Morena	Madhya Pradesh	197670	17.4	-	0	Kunwari
19	Indore	Madhya Pradesh	1885510	212.5	90	0.4235	Khan, Shipra
20	Sagar	Madhya Pradesh	304340	26.7	-	0	Dhasan
21	Bhind	Madhya Pradesh	201440	17.7	-	0	Chambal
22	Neemuch	Madhya Pradesh	140820	12.4	-	0	Chambal
23	Mandsaur	Madhya Pradesh	152590	15.8	-	0	Chambal
24	Dewas	Madhya Pradesh	302160	26.5	-	0	Chhoti Kali Sindh
25	Vidisha	Madhya Pradesh	164350	14.4	9	0.625	Betwa
26	Bhopal	Madhya Pradesh	1878380	255.2	17.64	0.0691	Betwa
27	Rewa	Madhya Pradesh	240030	21.1	-	0	Baichaiya
28	Guna	Madhya Pradesh	179640	15.8	-	0	Sindh
29	Damoh	Madhya	146930	14.1	-	0	Sonar,

		Pradesh					Bearma
30	Satna	Madhya Pradesh	295360	26	-	0	Tons
31	Shivpuri	Madhya Pradesh	192390	17	-	0	Sindh
32	Singrauli	Madhya Pradesh	243110	21.3	-	0	Gopad,Sone
33	Gwalior	Madhya Pradesh	1083260	114.1	-	0	Vaishali
34	Ujjain	Madhya Pradesh	563210	49.4	-	0	Shipra
35	Tonk	Rajasthan	166870	21.4	-	0	Banas
36	Kota	Rajasthan	855960	145	-	0	Chambal
37	Udaipur	Rajasthan	478860	61.5	-	0	Banas/Berach
38	Bhilwara	Rajasthan	344630	44.3	-	0	Banas
39	Alwar	Rajasthan	320100	41.1	-	0	Arvari
40	Moradabad	Uttar Pradesh	788730	86	-	0	Ramganga
41	Deoria	Uttar Pradesh	128190	14	-	0	Lttle Gandak
42	Rampur	Uttar Pradesh	346310	37.7	-	0	Kosi
43	Banda	Uttar Pradesh	165830	18.1	-	0	Ken
44	Aligarh	Uttar Pradesh	821310	89.5	-	0	Karwan
45	Meerut	Uttar Pradesh	1321300	144	-	0	Kali
46	Muzaffarnagar	Uttar Pradesh	389040	58	32	0.5517	Kali
47	Gonda	Uttar Pradesh	150260	16.4	-	0	Ghaghara
48	Hapur	Uttar Pradesh	260740	28.4	-	0	Kali
49	Bulandshahr	Uttar Pradesh	216790	23.6	-	0	Kali
50	Modinagar	Uttar Pradesh	148300	15.1	-	0	Kali
51	Ghaziabad	Uttar Pradesh	1191280	129.8	126	0.9707	Hindon River
52	Saharanpur	Uttar Pradesh	557100	60.7	38	0.626	Hindon River
53	Gorakhpur	Uttar Pradesh	768220	83.7	-	0	Haldi, Rapti
54	Sultanpur	Uttar Pradesh	123100	13.4	6.4	0.4776	Gomti River
55	Lucknow	Uttar Pradesh	2715030	295.8	417	1	Gomti River
56	Jaunpur	Uttar Pradesh	196800	21.4	-	0	Gomti
57	Bahraich	Uttar Pradesh	207100	22.6	-	0	Ghaghara
58	Faizabad	Uttar Pradesh	178260	19.4	-	0	Ghaghara
59	Basti	Uttar Pradesh	131590	14.3	-	0	Ghaghara
60	Lakhimpur	Uttar Pradesh	148300	16.2	-	0	Ghaghara
61	Shahjahanpur	Uttar Pradesh	366460	40	-	0	Deoha
62	Pilibhit	Uttar Pradesh	152620	16.6	-	0	Deoha
63	Maunath Bhanjan	Uttar Pradesh	258390	28.2	-	0	Chhoti Saryu
64	Azamgarh	Uttar Pradesh	129080	14.1	-	0	Chhoti Saryu

65	Jhansi	Uttar Pradesh	471400	51.4	-	0	Betwa
66	Lalitpur	Uttar Pradesh	137530	15	-	0	Betwa
67	Chandausi	Uttar Pradesh	127620	14	-	0	Badaun Streatm
68	Sambhal	Uttar Pradesh	225000	24.5	-	0	Badaun Stream
69	Amroha	Uttar Pradesh	202810	22.1	-	0	Badaun Stream
70	Budaun	Uttar Pradesh	182210	20	-	0	Badaun Stream
71	Sitapur	Uttar Pradesh	186750	20.3	-	0	Saranga n
72	Bareily	Uttar Pradesh	860800	93.8	-	0	Ramgan ga
73	Rae Bareli	Uttar Pradesh	208220	22.7	-	0	Sai
74	Etah	Uttar Pradesh	131730	15.8	-	0	Sirsa
75	Hardoi	Uttar Pradesh	138340	15.1	-	0	Sai
76	Kathgodam-Haldwani	Uttarakhand	158840	17.3	-	0	Ramgan ga
77	Kharagpur	West Bengal	239180	28.1	-	0	Kosai
78	Medinipur	West Bengal	176350	20.7	-	0	Kosai
79	Krishnanagar	West Bengal	159930	18.8	-	0	Jalangi
80	Puruliya	West Bengal	130830	15.4	-	0	Haldi
81	Asansol	West Bengal	1090171	65.7	-	0	Damodar
82	Durgapur	West Bengal	566950	66.6	-	0	Damodar
83	Raniganj	West Bengal	190010	16.6	-	0	Damodar
84	Baharampur	West Bengal	184190	21.6	8	0.3704	Beel
85	Bankura	West Bengal	148130	17.4	-	0	Roopnar ayan
86	Barasat	West Bengal	266240	31.3	-	0	Bidyadha ri
87	Kulti	West Bengal	333570	39.2	-	0	Damodar
88	Jamuria	West Bengal	148870	17.5	-	0	Damodar
89	Bardhaman	West Bengal	328750	38.6	-	0	Damodar
90	Panihati	West Bengal	400640	47	16.5	0.3511	Irrigation , Pissic,Ca nal
91	Bally	West Bengal	300810	35.3	45	1	Irrigation, Pissic,Ca nal
92	Titagarh	West Bengal	142830	16.8	23	1	Irrigation, Pissicult, Khal
93	Siliguri	West Bengal	540820	63.5	-	0	Mahanan da
94	Hugli-Chinsurah	West Bengal	195730	23	-	0	Mahanan da
95	Raiganj	West Bengal	190010	22.3	-	0	Mahanan da
96	Balurghat	West Bengal	155840	18.3	-	0	Padma
97	Madhyamgram	West Bengal	178830	21	-	0	Sunti
98	Delhi	Delhi	14858800	2948	2330	0.7904	Yamuna
99	Palwal	Haryana	132700	10	9	0.9	Yamuna
100	Faridabad	Haryana	1392570	118.2	115	0.972	Yamuna

						9	
101	Panipat	Haryana	345400	26.7	45	1	Yamuna
102	Sonipat	Haryana	285400	21.2	30	1	Yamuna
103	Karnal	Haryana	277830	28.6	48	1	Yamuna
104	Gurgaon	Haryana	229080	17	30	1	Yamuna
105	Jagadhri	Haryana	133720	10	-	0	Yamuna
106	Agra	Uttar Pradesh	1549770	211.7	90.25	0.4263	Yamuna
107	Mathura	Uttar Pradesh	367560	40	27	0.675	Yamuna
108	Noida	Uttar Pradesh	361510	39.4	70	1	Yamuna
109	Firozabad	Uttar Pradesh	242930	37.4	-	0	Yamuna
110	Etawah	Uttar Pradesh	260100	28.3	10.45	0.3693	Yamuna
111	Fatehpur	Uttar Pradesh	186660	20.3	-	0	Yamuna
112	Hathras	Uttar Pradesh	151590	16.5	-	0	Yamuna
113	Orai	Uttar Pradesh	171520	18.7	-	0	Yamuna
	Total			7841.5			

Disposal In Land

S.NO	City/Town	State/UT	Population	Total Sewage (in MLD)	Treatment Capacity (in MLD)	Percentage covered	Treated sewage Disposal
1	Dinapur Nizamat	Bihar	191780	31	-	0	Land
2	Rohtak	Bihar	145980	23.6	-	0	Land
3	Hisar	Haryana	378540	28.1	-	0	Land
4	Bhiwani	Haryana	338990	25.2	-	0	Land
5	Hansi	Haryana	223640	17.6	-	0	Land
6	Narnaul	Haryana	99210	5.6	-	0	Land
7	Thanesar	Haryana	81340	4.5	-	0	Land
8	Jind	Haryana	158500	11.8	-	0	Land
9	Bahadurgarh	Haryana	179640	13.3	-	0	Land
10	Rewari	Haryana	158190	11.7	-	0	Land
11	Kaithal	Haryana	133250	10	-	0	Land
12	Mango	Haryana	154740	11.5	-	0	Land
13	Adityapur	Jharkhand	204290	30.1	-	0	Land
14	Murwara	Jharkhand	146640	21.6	-	0	Land
15	Katni)	Madhya Pradesh	244630	21.5	-	0	Land
16	Jaipur	Rajasthan	2858910	367.2	54	0.1471	Land
17	Jhunjhunun	Rajasthan	123590	16	-	0	Land
18	Loni	Uttar Pradesh	148410	16.2	-	0	Land
19	Baranagar	West Bengal	288210	33.8	44.5	1	Land
20	Rajarhat Gopalpur	West Bengal	312550	36.7	-	0	Land
21	Bidhan Nagar	West Bengal	193030	22.7	-	0	Land
22	English Bazar	West Bengal	185670	21.8	-	0	Land
23	Uttarpara Kotrung	West Bengal	172730	20.3	-	0	Land
24	Dumdum	West Bengal	116520	13.7	-	0	Land
25	Barrackpur	West Bengal	165980	19.5	22.15	1	Land
26	Khardaha	West Bengal	133690	15.7	3	0.191	Land

						1	
27	Baidyabati	West Bengal	124470	14.6	2	0.137	Land
28	Bhadreswar	West Bengal	121840	14.3	6	0.4196	Land
29	Bansberia	West Bengal	120120	14.1	2.8	0.1986	Land
30	Champdani	West Bengal	118720	14	12	0.8571	Land
	Total			907.4	146.5	0.1614	

Source: Central pollution control Board, 2010

Appendix 6

City wise water supply in class II cities of Ganga Basin						
S.No.	**State / Union Territory**	**Population in year 2008**	**Water supply (MLD)**	**Percapita water supply (lpcd)**	**Per capita sewage (lpcd)**	**Total sewage (MLD)**
	Bihar					
1	Araria	72710	8.36	114.9773071	92	6.69
2	Aurangabad	95220	10.95	114.9968494	92	8.76
3	Buxar	99570	11.45	114.9944762	92	9.16
4	Gopalganj	65300	7.51	115.007657	92	6.01
5	Jamui	80100	9.21	114.9812734	92	7.37
6	Jehanabad	98070	11.28	115.0198838	92	9.02
7	Lakhisarai	93410	10.74	114.9769832	92	8.59
8	Madhubani	79540	9.15	115.0364596	92	7.32
9	Nawada	98750	11.36	115.0379747	92	9.09
10	Phulwari Sharif	63800	7.34	115.0470219	92	5.87
11	Mokameh	67680	12.01	177.4527187	142	9.61
12	Samastipur	66710	7.68	115.1251686	92	6.14
13	Sitamarhi	68120	9.79	143.7169701	115	7.83
14	Supaul	64820	7.45	114.9336624	92	5.96
	Total	1113800	134.28			107.42
	Haryana					
1	Ambala Cantt.	80730	7.26	89.92939428	72	5.81
2	Tohana	67490	6.08	90.08742036	72	4.86
3	Fatehabad	78420	7.5	95.63886764	76.51	9.79
4	Hansi	99210	9.18	92.53099486	74	7.34
5	Narwana	66360	5.98	90.11452682	72	4.78
6	Narnaul	81340	7.33	90.1155643	72	5.86
7	Mandi Dabwali	70490	6.35	90.08369982	72	5.08
	Total	544040	49.68			43.52
	Jharkhand					
1	Katras	61420	7.06	114.9462716	92	5.65
2	Tisra	64260	7.39	115.0015562	92	5.91
3	Sindri	92190	10.6	114.9799327	92	8.48
4	Jharia	98370	11.31	114.9740775	92	9.05
5	Ramgarh Cantonment	88150	10.8	122.5184345	98	8.64
6	Jhumri Tilaiya	83330	11.66	139.925597	112	9.33
7	Daltonganj	85570	9.84	114.9935725	92	7.87
8	Chaibasa	76340	8.78	115.0117894	92	7.02
9	Bagbera	80520	9.26	115.0024839	92	7.41
10	Sahibganj	96150	11.06	115.0286011	92	8.85
	Total	826300	97.76			78.21
	Madhya Pradesh					
1	Balaghat	77310	10	129.3493727	103.48	8
2	Betul	85790	3.39	39.515095	31.61	2.712

3	Sarni	97870	8.81	90.01736998	72	7.05
4	Datia	85220	7.68	90.11969021	72	6.14
5	Pithampur	70090	6.31	90.027108	72	5.05
6	Dhar	77740	7	90.04373553	72	5.6
7	Ashok Nagar	59410	5.35	90.05217977	72	4.28
8	Dabra	58360	2.02	34.61274846	27.69	1.616
9	Harda	63560	4.14	65.13530522	52.11	3.312
10	Itarsi	96600	8.7	90.0621118	72	6.96
11	Mhow Cantt.	87570	17.74	202.5807925	162	14.19
12	Jabalpur Cantt.	68480	2.01	29.35163551	23.48	1.608
13	Jaora	65650	4.4	67.02208682	53.62	3.52
14	Bina Etawa	52720	9.23	175.0758725	140	7.38
15	Sehore	93660	7.2	76.87379885	61.5	5.76
16	Seoni	92490	12	129.7437561	103.8	9.6
17	Shahdol	80940	7.13	88.08994317	70.47	5.704
18	Shajapur	51590	4.5	87.22620663	69.78	3.6
19	Sheopur	56680	5.1	89.97882851	72	4.08
20	Tikamgarh	70630	6.36	90.04672236	72	5.09
21	Nagda	99420	4.65	46.77127339	37.42	3.72
22	Basoda	64230	5.78	89.98910167	72	4.62
23	Khargone	89040	14.14	158.8050314	127	11.31
	Total	1745050	163.64			130.902
	Rajasthan					
1	Banswara	97630	8.05	82.45416368	66	6.44
2	Baran	89340	7	78.35236176	62.68	5.6
3	Balotra	70370	5.8	82.42148643	66	4.64
4	Barmer	95210	18	189.0557715	151.24	14.4
5	Nimbahera	60790	5.01	82.41487087	66	4.01
6	Ratangarh	72350	5.98	82.65376641	66	4.78
7	Sardarshahar	92770	7.65	82.4620028	66	6.12
8	Sujangarh	95540	7.89	82.58321122	66	6.31
9	Dausa	70210	12.5	178.0373166	142.43	10
10	Bari	57540	4.75	82.55126868	66	3.8
11	Suratgarh	66210	6.55	98.92765443	79.14	5.24
12	Chomu	57820	40	691.8021446	553.44	32
13	Jaisalmer	66450	5.49	82.61851016	66	4.39
14	Nawalgarh	64390	5.31	82.46622146	66	4.25
15	Karauli	75440	6.23	82.58218452	66	4.98
16	Hindaun	96650	7.98	82.56595965	66	6.38
17	Kuchaman City	57650	4.75	82.39375542	66	3.8
18	Ladnu	65030	5.36	82.42349685	66	4.29
19	Makrana	94950	7.84	82.56977357	66	6.27
20	Rajsamand	63460	5.24	82.57169871	66	4.19
21	Fatehpur	89460	7.38	82.49496982	66	5.9
	Total	1599260	184.76			147.79
	Uttar Pradesh					
1	Agra	65410	7.85	120.0122305	96	6.28
2	Tanda	96700	11.6	119.958635	96	9.28
3	Auraiya	75190	15.03	199.8936029	159.91	12.024
4	Mubarakpur	59460	9.14	153.7167844	123	7.31
5	Baraut	99900	11.99	120.02002	96	9.59

6	Balrampur	84060	5.3	63.05020224	50.44	4.24
7	Nawabganj	87400	10.89	124.5995423	99.68	8.712
8	Baheri	68180	8.19	120.1232033	96	6.55
9	Faridpur	71030	8.53	120.0901028	96	6.82
10	Sherkot	61540	7.39	120.0844979	96	5.91
11	Kiratpur	64380	7.73	120.0683442	96	6.18
12	Chandpur	79570	1.66	20.86213397	16.69	1.328
13	Nagina	83000	9.96	120	96	7.97
14	Najibabad	92060	11.05	120.0304149	96	8.84
15	Bijnor	92380	11.09	120.0476294	96	8.87
16	Ujhani	59420	45	757.3207674	605.86	36
17	Sahaswan	67740	8.13	120.0177148	96	6.5
18	Jahangirabad	59790	7.18	120.0869711	96	5.74
19	Sikandrabad	81370	9.76	119.945926	96	7.81
20	Dadri	66880	8.03	120.0657895	96	6.42
21	Pilkhuwa	78210	9.39	120.0613732	96	7.51
22	Muradnagar	86230	1.26	14.61208396	11.69	1.008
23	Rath	65110	7.81	119.9508524	96	6.25
24	Shahabad	78760	9.45	119.9847638	96	7.56
25	Jalaun	58240	6.99	120.0206044	96	5.59
26	Konch	59050	7.09	120.0677392	96	5.67
27	Mauranipur	59230	7.11	120.04052	96	5.69
28	Hasanpur	62090	7.45	119.9871155	96	5.96
29	Chhibramau	58520	7.03	120.1298701	96	5.62
30	Kannauj	83260	9.99	119.9855873	96	7.99
31	Gola Gokarannath	62660	7.53	120.1723588	96	6.02
32	Mahoba	91730	11.01	120.0261637	96	8.81
33	Vrindavan	65900	7.91	120.030349	96	6.33
34	Mawana	80550	9.66	119.9255121	96	7.73
35	Khatauli	68090	8.18	120.1351153	96	6.54
36	Kairana	85030	10.2	119.957662	96	8.16
37	Bisalpur	70630	8.48	120.0622965	96	6.78
38	Bela Pratapgarh	83620	11.71	140.0382684	112	9.37
39	Gangoh	62790	7.54	120.0828157	96	6.03
40	Deoband	95110	11.41	119.9663547	96	9.13
41	Bhadohi	86650	10.4	120.0230814	96	8.32
42	Tilhar	61590	7.39	119.9870109	96	5.91
43	Laharpur	58290	7	120.0892091	96	5.6
44	Obra	60990	7.33	120.1836367	96	5.86
45	Renukoot	62300	7.48	120.0642055	96	5.98
46	Gangaghat	82430	9.89	119.9805896	96	7.91
	Total	3382520	432.19			345.702
	Uttarakhand					
1	Rishikesh	69460	11.34	163.2594299	130.61	9.072
	Total	69460	11.34			9.072
	West Bengal					
1	Bishnupur	70180	7.55	107.5805073	86	6.04
2	Kalna	59120	6.35	107.4086604	86	5.08
3	Katwa	81090	2.728	33.64163275	26.91	2.1824

4	Rampurhat	57340	6.16	107.4293687	86	4.93
5	Suri	70040	8.4	119.9314677	96	6.72
6	Bolpur	74390	8	107.5413362	86	6.4
7	Gangarampur	60670	12.5	206.0326356	164.83	10
8	Arambag	63590	6.84	107.5640824	86	5.47
9	Konnagar	81820	11.8	144.2190174	115.38	9.44
10	Alipurduar	82760	8.9	107.5398743	86	7.12
11	Koch Bihar	87030	12	137.8834885	110.31	9.6
12	Old Maldah	71320	2.8	39.25967471	31.41	2.24
13	Ghatal	58450	6.29	107.6133447	86	5.03
14	Jhargram	60230	6.48	107.5875809	86	5.18
15	Contai	87800	9.44	107.5170843	86	7.55
16	Kandi	57040	0.454	7.959326788	6.37	0.3632
17	Dhulian	82600	8.88	107.5060533	86	7.1
18	Jangipur	84370	4.5	53.33649401	42.67	3.6
19	Phulia	56940	6.13	107.657183	86	4.9
20	Gayespur	62350	7	112.2694467	89.82	5.6
21	Ranaghat	77900	10	128.3697047	102.7	8
22	Kalyani	92890	23	247.6046937	198.08	18.4
23	Chakdaha	98530	11.83	120.0649548	96	9.46
24	Garulia	86460	11.77	136.1323155	108.91	9.416
25	New Barrackpur	94250	10.14	107.5862069	86	8.11
26	Budge Budge	85500	9.19	107.4853801	86	7.35
27	Islampur	59780	6.43	107.5610572	86	5.14
	Total	2004440	225.56			180.422

Source: CPCB 2010

Appendix 7

Sewage Generation in Class I Cities having no STPs - Ganga Basin						
S.No.	**City/Town**	**State/UT**	**Population**	**Total Sewage (in MLD)**	**Per capita sewage (l/d)**	**Treated sewage Disposal**
1	Ballia	Uttar Pradesh	125740	18	143.152537	Ganga Basin
2	Dehradun	Uttarakhand	550800	76.1	138.1626725	Ganga Basin
3	Basirhat	West Bengal	130090	15.3	117.6108848	Ganga Basin
4	Bangaon	West Bengal	117430	13.8	117.5168185	Ganga Basin
5	North Dumdum	West Bengal	253040	29.7	117.3727474	Ganga Basin
6	Naihati	West Bengal	247750	20.5	82.74470232	Ganga Basin
7	Ulberia	West Bengal	232410	27.3	117.4648251	Ganga Basin
8	Kanchrapara	West Bengal	145040	17	117.2090458	Ganga Basin
9	Halisahar	West Bengal	143150	16.8	117.3594132	Ganga Basin
10	Habra	West Bengal	146850	17.2	117.1263194	Ganga Basin
11	Muzaffarpur	Bihar	342120	55.3	161.6391909	Budhi Gandak
12	Bihar Sharif	Bihar	259810	42	161.6565952	Phalgun
13	Gaya	Bihar	429180	69.4	161.7037141	Phalgun
14	Bettiah	Bihar	130700	21.1	161.4384086	Budhi Gandak
15	Motihari	Bihar	113690	18.4	161.8436098	Budhi Gandak
16	Hajipur	Bihar	133590	21.6	161.6887492	Gandak
17	Darbhanga	Bihar	298850	48.3	161.6195416	Ghughri
18	Sasaram	Bihar	146770	23.7	161.4771411	Chandrabhaga
19	Siwan	Bihar	121150	19.6	161.7829137	Daha
20	Arrah	Bihar	227800	36.8	161.5452151	Son
21	Dehri	Bihar	133290	21.5	161.3024233	Son
22	Saharsa	Bihar	138900	22.4	161.2670986	Simrahi Stream
23	Bokaro	Jharkhand	484830	71.3	147.0618567	Damodar
24	Dhanbad	Jharkhand	1064357	36	33.82323788	Damodar
25	Hazaribagh	Jharkhand	156510	23	146.9554661	Damodar
26	Morena	Madhya Pradesh	197670	17.4	88.02549704	Kunwari
27	Sagar	Madhya Pradesh	304340	26.7	87.73082736	Dhasan
28	Bhind	Madhya Pradesh	201440	17.7	87.86735504	Chambal
29	Neemuch	Madhya Pradesh	140820	12.4	88.05567391	Chambal
30	Mandsaur	Madhya Pradesh	152590	15.8	103.5454486	Chambal
31	Dewas	Madhya Pradesh	302160	26.5	87.7018798	Chhoti Kali Sindh
32	Rewa	Madhya Pradesh	240030	21.1	87.90567846	Baichaiya
33	Guna	Madhya Pradesh	179640	15.8	87.95368515	Sindh
34	Damoh	Madhya Pradesh	146930	14.1	95.96406452	Sonar, Bearma
35	Satna	Madhya Pradesh	295360	26	88.02816901	Tons
36	Shivpuri	Madhya	192390	17	88.36218099	Sindh

		Pradesh				
37	Singrauli	Madhya Pradesh	243110	21.3	87.61466003	Gopad,Sone
38	Gwalior	Madhya Pradesh	1083260	114.1	105.330207	Vaishali
39	Ujjain	Madhya Pradesh	563210	49.4	87.7115108	Shipra
40	Tonk	Rajasthan	166870	21.4	128.2435429	Banas
41	Kota	Rajasthan	855960	145	169.4004393	Chambal
42	Udaipur	Rajasthan	478860	61.5	128.4300213	Banas/Berach
43	Bhilwara	Rajasthan	344630	44.3	128.5436555	Banas
44	Alwar	Rajasthan	320100	41.1	128.3973758	Arvari
45	Moradabad	Uttar Pradesh	788730	86	109.0360453	Ramganga
46	Deoria	Uttar Pradesh	128190	14	109.2128871	Lttle Gandak
47	Rampur	Uttar Pradesh	346310	37.7	108.8620023	Kosi
48	Banda	Uttar Pradesh	165830	18.1	109.1479226	Ken
49	Aligarh	Uttar Pradesh	821310	89.5	108.9722516	Karwan
50	Meerut	Uttar Pradesh	1321300	144	108.9835768	Kali
51	Gonda	Uttar Pradesh	150260	16.4	109.1441501	Ghaghara
52	Hapur	Uttar Pradesh	260740	28.4	108.920764	Kali
53	Bulandshahr	Uttar Pradesh	216790	23.6	108.8611098	Kali
54	Modinagar	Uttar Pradesh	148300	15.1	101.8206339	Kali
55	Gorakhpur	Uttar Pradesh	768220	83.7	108.9531645	Haldi, Rapti
56	Jaunpur	Jaunpur	196800	21.4	108.7398374	Gomti
57	Bahraich	Bahraich	207100	22.6	109.1260261	Ghaghara
58	Faizabad	Faizabad	178260	19.4	108.8297992	Ghaghara
59	Basti	Basti	131590	14.3	108.6708716	Ghaghara
60	Lakhimpur	Lakhimpur	148300	16.2	109.238031	Ghaghara
61	Shahjahanpur	Shahjahanpur	366460	40	109.1524314	Deoha
62	Pilibhit	Pilibhit	152620	16.6	108.766872	Deoha
63	Maunath Bhanjan	Maunath Bhanjan	258390	28.2	109.1373505	Chhoti Saryu
64	Azamgarh	Azamgarh	129080	14.1	109.2345832	Chhoti Saryu
65	Jhansi	Jhansi	471400	51.4	109.0369113	Betwa
66	Lalitpur	Lalitpur	137530	15	109.0671126	Betwa
67	Chandausi	Chandausi	127620	14	109.7006739	Badaun Streatm
68	Sambhal	Sambhal	225000	24.5	108.8888889	Badaun Stream
69	Amroha	Amroha	202810	22.1	108.9689858	Badaun Stream
70	Budaun	Budaun	182210	20	109.7634597	Badaun Stream
71	Sitapur	Sitapur	186750	20.3	108.7014726	Sarangan
72	Bareily	Bareily	860800	93.8	108.9684015	Ramganga
73	Rae Bareli	Rae Bareli	208220	22.7	109.0193065	Sai
74	Etah	Etah	131730	15.8	119.9423062	Sirsa
75	Hardoi	Hardoi	138340	15.1	109.1513662	Sai
76	Kathgodam-Haldwani	Kathgodam-Haldwani	158840	17.3	108.9146311	Ramganga
77	Kharagpur	Kharagpur	239180	28.1	117.4847395	Kosai
78	Medinipur	West Bengal	176350	20.7	117.3802098	Kosai
79	Krishnanagar	West Bengal	159930	18.8	117.5514288	Jalangi
80	Puruliya	West Bengal	130830	15.4	117.7100054	Haldi

81	Asansol	West Bengal	1090171	65.7	60.26577482	Damodar
82	Durgapur	West Bengal	566950	66.6	117.4706764	Damodar
83	Raniganj	West Bengal	190010	16.6	87.36382296	Damodar
84	Bankura	West Bengal	148130	17.4	117.4643894	Roopnarayan
85	Barasat	West Bengal	266240	31.3	117.563101	Bidyadhari
86	Kulti	West Bengal	333570	39.2	117.5165632	Damodar
87	Jamuria	West Bengal	148870	17.5	117.5522268	Damodar
88	Bardhaman	West Bengal	328750	38.6	117.4144487	Damodar
89	Siliguri	West Bengal	540820	63.5	117.4142968	Mahananda
90	Hugli-Chinsurah	West Bengal	195730	23	117.5088132	Mahananda
91	Raiganj	West Bengal	190010	22.3	117.3622441	Mahananda
92	Balurghat	West Bengal	155840	18.3	117.4281314	Padma
93	Madhyamgram	West Bengal	178830	21	117.4299614	Sunti
94	Jagadhri	Haryana	133720	10	74.78312893	Yamuna
95	Firozabad	Uttar Pradesh	242930	37.4	153.9538139	Yamuna
96	Fatehpur	Uttar Pradesh	186660	20.3	108.7538841	Yamuna
97	Hathras	Uttar Pradesh	151590	16.5	108.84623	Yamuna
98	Orai	Uttar Pradesh	171520	18.7	109.0251866	Yamuna
99	Dinapur Nizamat	Bihar	191780	31	161.6435499	Land
100	Rohtak	Bihar	145980	23.6	161.6659816	Land
101	Hisar	Haryana	378540	28.1	74.2325778	Land
102	Bhiwani	Haryana	338990	25.2	74.33847606	Land
103	Hansi	Haryana	223640	17.6	78.69790735	Land
104	Narnaul	Haryana	99210	5.6	56.44592279	Land
105	Thanesar	Haryana	81340	4.5	55.32333415	Land
106	Jind	Haryana	158500	11.8	74.44794953	Land
107	Bahadurgarh	Haryana	179640	13.3	74.03696281	Land
108	Rewari	Haryana	158190	11.7	73.96169164	Land
109	Kaithal	Haryana	133250	10	75.04690432	Land
110	Mango	Haryana	154740	11.5	74.31821119	Land
111	Adityapur	Jharkhand	204290	30.1	147.3395663	Land
112	Murwara	Jharkhand	146640	21.6	147.299509	Land
113	Katni)	Madhya Pradesh	244630	21.5	87.8878306	Land
114	Jhunjhunun	Rajasthan	123590	16	129.4603123	Land
115	Loni	Uttar Pradesh	148410	16.2	109.1570649	Land
116	Rajarhat Gopalpur	West Bengal	312550	36.7	117.4212126	Land
117	Bidhan Nagar	West Bengal	193030	22.7	117.5983008	Land
118	English Bazar	West Bengal	185670	21.8	117.4126138	Land
119	Uttarpara Kotrung	West Bengal	172730	20.3	117.5244601	Land
120	Dumdum	West Bengal	116520	13.7	117.5763817	Land

Source: Central Pollution Control Board

Appendix 8

List of Polluted River Stretches within Ganga Basin				
S. No.	**State / River**	**Polluted Stretch**	**Source / Town**	**Critical Parameters (in mg/l)**
1	**Bihar**	Information not available (possibly no polluted stretches within the State)		
2	**Uttarakhand**	Information not available (possibly no polluted stretches within the State)		
3	**Jharkhand**			
	River Subarnrekha	Ranchi to D/S of Jamshedpur	Industrial & domestic waste from Ranchi and Jamshedpur	Not Available
4	**Delhi**			
	River Yamuna	Wazirabad to Okhla	Industrial & domestic waste from Delhi	BOD – 6 - 77
5	**Haryana**			
	River Ghaggar	Interstate border with Punjab to Ottu weir at Sirsa	Industrial and Municipal waste from Sirsa	BOD – 8 - 50
	River Yamuna	Okhla to Kosi Kalan	Industrial & domestic waste from Faridabad and Palwal	BOD – 16
	Drain No. 8	Sonepat to Confl. With Yamuna	Industrial and Municipal waste from Sonepat	BOD – 6 - 36
6	**Himachal Pradesh**			
	River Markanda	Kala Amb D/S to Haryana Border	Industrial and Municipal waste from Kala Amb	BOD – 55 Colour - 1009 Hazen
	Renuka Lake	–	–	BOD – 8
7	**Madhya Pradesh**			
	River Khan	Indore City to Confluence with Kshipra	Indore - Sewage	BOD – 65-120
	River Kshipra	Ujjain to confluence with Chambal	Ujjain - Sewage	BOD – 8-24
	River Chambal	D/S of Nagda	Industrial waste - Grasim & Nagda Sewage	BOD – 8-24

	River Tapi	D/S of Napanagar to Burhanpur City	Domestic & Industrial waste water from Nepanagar and Burhanpur	Not Available
	Lake	Lower and Upper Lake, Bhopal	Bhopal Sewage	BOD – 6-8
8	**Rajasthan**			
	River Ghaggar	Ottu weir to Hanumangarh	Industrial & domestic waste from Haryana and Punjab	Not Available
	River Chambal	D/S Kota city	Industrial & domestic waste from Kota	BOD – 6 - 6.4
	River Banas Berach River	Udaipur to Chittorgarh	Municipal waste from Udaipur and Chittorgarh	Not Available
9	**Uttar Pradesh**			
	River Yamuna	Kosi Kalan to Confl. with Chambal	Sewage from Agra, Vrindavan, Mathura and Etawah	BOD – 6 - 37
	River Hindon	Saharanpur to Confl. with Yamuna	Sewage and Industrial effluent from Sahranpur, Muzaffar Nagar and Ghaziabad	BOD – 9 - 36
	River Western Kali	Muzzafar Nagar to Confluence with Hindon	Sewage and Industrial effluents from Muzaffar Nagar and Mansoorpur	BOD – 21 - 44
	River Buri Yamuna	Pilkhani to Confluence with Yamuna	Industrial effluent of Pilkhani Distillery	Not Available
	River Kali Nadi Eastern	Meerut to Kannauj	Industrial and Municipal sewage from Meerut, Modi Nagar, Hapur, Bulandsahar, Gulwati and Kannauj	BOD – 43 - 135
	River Gomati	Lucknow to Confluence with Ganga	Sewage and Industrial effluent from Lucknow,	BOD – 6 - 8.2 BOD – 6 - 7.6

			Sultanpur, Jaunpur	
	River Ganga	Kannauj to Kanpur	Discharge through Kalinadi & Ramganga sewage and Industrial effluent from Kannauj and Kanpur	BOD – 6 - 10
	River Ganga	Varanasi D/S	Varanasi sewage and Industrial effluent	BOD – 6.5 - 16.5
10	**West Bengal**			
	River Damodar	Durgapur to Haldia	Industrial waste and sewage from Durgapur and Asansol	BOD – 6.4 - 32

Appendix 9

River Basin wise distribution of Water Quality Monitoring Stations (as of year - 2007		
S. No.	**River (main stream), Tributaries and Sub-Tributaries, Lake, Ponds, Tanks, Canals, Creeks and Groundwater Stations**	**Total Stations**
1	**Baitarni (5)**	5
2	**Brahmani (11)** **Tributaries-**Karo (1), Koel (2), Sankh (1)	15
3	**Brahmaputra (10)** **Tributaries-**Burhidihing (3), Dhansiri (7), Disang (2), Jhanji (1), Subansiri (1), Bhogdoi (1), Bharalu (1), Borak (2), Deepar Bill (1), Digboi (1), Mora Bharali (1), Teesta (5), Dickhu (1), Maney (2), Ranichu (2), Rangit (5), Jai Bharali (1), Kathakal (1), Kharsang (1), Kolong (2), Manas(1), Pagldia (1), Chathe (1), Dzu (1), Kapili(1), Beki(1), Kundli(1), Kushiara(1), Panchnai(1), Sankosh(1), Sonai(1), Kohara(1), Ranga(1), Boginadi(1), Dikhow(1)	66
4	**Cauvery (20)** **Tributaries-**Arkavati (1), Amravati (1), Bhawani (5), Kabini (4), Laxmantirtha (1), Shimsa (2), Hemavati (1), Yagachi (1)	36
5	**Ganga (34)** **Tributaries-**Alakananda-Upper Ganga (4), Mandakini-Upper Ganga (1), Barakar (1), Betwa (10), Chambal (8), Damodar (5), Gandak (1), Saryu-Ghaghra (3), Gomti (5), Hindon (3), Kali (West) (2), Kali Nadi(East) (2), Khan (3), Kshipra (3), Mahananda (1), Mandakini (Madhya Pradesh) (1), Parvati (2), Ramganga (1), Rapti (1), Rihand (2), Rupanarayan (1), Sai (1), Sone (5), Tons (Madhya Pradesh) (2), Yamuna (23), Sindh (1), Johila (1), Sankh(1), Gohad (1), Kolar (1), Churni (2), Tons (Himachal Pradesh) (1), Sikrana (1), Daha (1), Sirsa (1), Dhous (1), Farmer (1), Kalia sot(1), Bihar(1), Bichia(1)	141
6	**Godavari (22)** **Tributaries-** Manjara (Manjira) (3), Maner (2), Nira (1), Wainganga (8), Wardha (3), Kolar (1), Kanhan (3), Purna (2), Indravati (2), Sankhani (1)	48
7	**Indus** **Tributaries-**Beas (19), Chenab (1), Jhelum (3), Largi (1), Parvati (3), Ravi (3), Sutlej (21), Tawi (1), Gawkadal (1), Chuntkol (1), Sirsa (3), Swan (1)	58
8	**Krishna (22)** **Tributaries-** Bhadra (3), Bhima (10), Ghataprabha (2), Malprabha (3), Muneru (1), Musi (2), Nira (2), Paleru (1), Tunga (1), Tungabhadra (6), Panchganga (4), Chandrabhaga (2), Kagina(1), Koyna(1), Mula(2), Mutha(1), Mula-Mutha(1), Venna(1), Pawana(1), Indrayani(1)	68
9	**Mahi (9)** **Tributaries-**Anas (1), Panam (1) , Jammer(1), Malei(1), Shivna(1), Chillar(1)	15
10	**Mahanadi (18)** **Tributaries-Ib (4),** Hasdeo (2), Kathajodi (1), Kharoon (4), Kuakhai (2), Sheonath (3), Birupa (1), Arpa (1), Kelo (2)	38
11	**Narmada (21)** **Tributaries-**Chhota Tawa (1), Gour(1), Katni(1), Kunda(1)	25
12	**Pennar (5)**	5

13	**Sabarmati (9)** **Tributaries-**Meswa (1), Shedhi (1), Khari (1)	12
14	**Subarnerekha (6)**	6
15	**Tapi (14)** **Tributaries-**Girna (2), Rangavali (1), Denwa(1), Kim(1)	19
16	**Medium rivers** Ambika (1), Ulhas (3), Ulhas-Bhatsa (1), Ulhas-Kalu (1), Imphal (4), Mandovi (2), Palar (1), Pamba (3), Pariyar (3), Rushikulya (2), Tambiraparani (7), Achankoil (2), Chalakudy (1), Damanganga (6), Ghaggar (19), Kallada (1), Kali-Karnataka (1), Manimala (2), Mindhola (1), Nagavalli (3), Amlakhadi (2), Chaliyar (2), Iril (2), Kharkhala (1), Karmana (1), Kolak (2), Kundalika (2), Meenachil (1), Muvattupuza (1), Patalganga (2), Umtrew (1), Vamanpuram(1), Zuari(2), Gumti(2), Kalna (1),Valvant (1), Madai (1), Khandepar (2), Asanora (1), Bhadar (1), Neyyar (1), Ithikkara (1), Kadalundy (1), Kuttiyady (1), Mahe (1), Kuppum (1), Neelsvaram (1), Karingoda (1), Chandergiri (1), Chitrapuzha (1), Nambul (2), Ganol (1), Simsang (1), Myntdu (1), Arasalar (1), Kodra (1), Haora (1), Khuga (1), Khujairok (1), Sekmai (1), Markanda (1), Sukna (1), Baleshwar Khadi (1), Netravati (1), Kumardhara (1), Purna (1), Kaveri (1), Dhadar (1), Tlawng (2), Tuirial (2), Talpona (1), Bhogavo(1), Triveni sangam(1), Mapusa(1), Bicholim(1), Chapora(1), Kushawati(1), Sal(2), Meethi(1), Savitri(1), Vashisti(1)	138
17	**Lakes (87)** Hussainsagar (1), Saroornagar (1), Himayatsagar (1), Pulicate (1), Salaulim (1), Kankoria (1), Chandola (1), Ajwah (1), Sursagar (1), Brahamsarovar (1), Sukhna (2), Govindsagar (1), Pongdam (1), Renuka (1), Wuller (1), Dal (1), Ulsoor (1), HebbalaValley (1), Oruvathikotta (1), Sasthamcotta (1), Ashthamudi (1), Paravur (1), Vembanad (1), Periyar (1), Kodumgallor (1), Kayamkula (1), Punnamadakayal (1), Pookotekayal (1), UpperLake (4), LowerLake (1), MultaiLake (1), Loktak (4), Umiam (1), Ward (1), Thadlaskena (1), Osteri (1), Bahour (1), Harike (2), Pichola (1), Udaisagar (1), Ramgarh Jaipur (1), Pushkar (1), Fatehsagar (1), Kalyana (1), Nakki (1), Udhagamadalam (1), Kodaikanal (1), Yercaud (1), Lakshminarayan Baridigh (1), Rudrasagar (1), Ramgarh-UttarPradesh (1), Naini (1), Rabindrasarovar (1), Nalsarovar (1), Bindusaraovar (1), Sahastrling Sarovar (1), Lakhota Talav (1), Narsimehta Talav (1), Nadiad city Lake (1), Ranjitnagar Talav (1), Ankleshwar reservoir(1), Dharoi dam(1), Kuwadava(1),Moticher lake(1), Mayem lake(1), Janunia talav(1), Yashwant sagar(1), Sirpur talav(1), Kali sindh reservoir(1), Periat tank(1), Shahpura (1), Madhav lake(1), Nagchun(1), Karwa dam(1), Khandari reservoir(1), Daloni Beel(1), Mer Beel(1), Govindgarh tank(1), Bilawali talav(1) **Tanks (6)** Dharamsagar (1), Bibinagar (1), Kistrapetrareddy (1), Goysagar (1), Thol (1), Gandigudem(1)	119

	Ponds (26) Elangabeel System (1), Lakshadweep (1), Olpad village pond (1),Bishnu Pushkar pukhuri(1), Bor Beel(1), Bor pukhuri(1), Botodriva pond(1), Chand dubi Beel(1), Deepar Beel(1), Dighali pukhuri(1), Dhudia talav(1), Baskandi pond(1), Galabeel(1), Ganga pukhuri(1), Gaurisagar(1), Gopur tank(1), Padum pukhuri(1), Hordai pukhuri(1), Jaipal pukhuri(1), Mahamaya mandir pukhuri(1), Rajadinia pukhuri(1), Raja pukhuri(1), Rajmaw pukhuri(1), Saranbeel(1), Sivasagar tank(1), Subhagya kund(1)	
18	**Creeks, Canals and Drains** Creeks (8),Sea Water(4), Agra Canal (1), Gurgaon Canal (1), Western Yamuna Canal (11), Agartala Canal (1), Cuncolim canal(2),Panoli canal(1), Narmada canal(1), Cumbarjua canal(1), Drains (18)	49
19	**Groundwater**	382
	Total India as a Whole	**1245**

Appendix 10

Frequency of National Water Quality Monitoring						
S. No.	**States**	**Monthly**	**Half Yearly**	**Quarterly**	**Yearly**	**Total**
1	Andhra Pradesh	14	24	21	–	**59**
2	Assam	6	32	63	–	**101**
3	Bihar	8	20	8	–	**36**
4	Chandigarh	–	7	4	–	**11**
5	Chhatisgarh	7	4	16	–	**27**
6	Dadra and Nagar Haveli	1	–	1	–	**2**
7	Daman & Diu	2	1	–	–	**3**
8	Delhi	14	–	1	–	**15**
9	Goa	20	6	3	–	**29**
10	Gujarat	38	42	33	–	**113**
11	Haryana	5	–	18	–	**23**
12	Himachal Pradesh	–	20	33	1	**54**
13	Jammu & Kashmir	–	–	9	–	**9**
14	Jharkhand	1	–	8	–	**9**
15	Karnataka	23	–	22	–	**45**
16	Kerala	10	15	30	–	**55**
17	Lakshdweep	–	15	1	–	**16**
18	Madhya Pradesh	50	18	37	–	**105**
19	Maharashtra	72	30	21	–	**123**
20	Manipur	–	5	15	–	**20**
21	Meghalaya	–	5	8	–	**13**
22	Mizoram	–	2	4	–	**6**
23	Nagaland	–	–	8	–	**8**
24	Orissa	14	15	25	–	**54**
25	Pondicherry	–	13	3	–	**16**
26	Punjab	–	6	37	–	**43**
27	Rajasthan	4	37	10	–	**51**
28	Sikkim	–	–	14	–	**14**
29	Tamil Nadu	20	2	10	–	**32**
30	Tripura	–	7	6	–	**13**
31	Uttar Pradesh	41	25	7	–	**73**
32	Uttarakhand	3	1	9	3	**16**
33	West Bengal	9	30	12	–	**51**
	Total	**362**	**382**	**497**	**4**	**1245**

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Appendix 11

State-wise details of population and number of cities

SNo.	State	Urban Population	No of Towns & Cities		Class- I Cities		Class- II Cities	
		1991	2001		No. of cities	Population	No. of cities	Population
1	Bihar (inc.Jharkhand)	6715096	14675541	215	29	9420222	22	1611324
2	Haryana	4054744	6115304	97	19	4437295	6	353506
3	Himachal Pradesh	449,196	595581	56	1	144975		
4	MadhyaPradesh (inc.Chhattisgarh)	12,152,967	20,152,892	452	33	11484099	31	2307600
5	Rajasthan	10,077,371	13,214,375	216	20	7561381	26	1841559
6	Uttar Pradesh	27,544,233	34539582	670	54	21377399	52	3531155
7	Uttarakhand		2179074	86	3	924900	4	368235
8	West Bengal	18,707,601	22,427,251	239	27	18728215	16	976655
9	Delhi	8,471,625	12,905,780	4	1	12877470		
	Total	88,172,833	128,984,454	1949	187	86955956	157	10990034

Source: Census 2001, National River Conservation Directorate, MoEF

Table No. 1: Demographic Details

State	Population			Literacy Rate	Scheduled Castes	Scheduled Tribes
	Total	Male	Female			
Jharkhand (District Sahibganj)	927,770	477,662	450,108	37.61	Total: 59,750 Chamar etc: 12,030 Dusadh etc: 9,960 Rajwas: 6,731	Total: 270,423 Santhal: 205,209 Mal Pahariya: 20,020 Sauria Paharia: 16,298
West Bengal (Kolkata)	4,572,876	2,500,040	2,072,836	80.86	Total: 274,835 Namasudra: 60,912 Pod etc.: 40,756 Chamar etc. 37,157	Total: 9 ,810 Generic Tribes: 1,989 Santal: 1,967 Oraon: 1 ,351

Bihar (Patna)	4,718,592	2,519,942	2,198,650	62.92	Total: 729,988 Dusadh etc.: 277,756 Chamar etc.: 199,423 Pasi: 93,200	Total: 9 ,236 Oraon: 2,341 Munda: 1,889 Gond: 1 ,556
Uttarakhand (Haridwar)	1,447,187	776,021	671,166	63.75	Total: 313,976 Chamar etc.: 268,489 Balmiki: 24,360 Generic Castes: 4,231	Total: 3, 139 Buksa: 2,890 Generic Tribes: 122 Bhotia: 64
Uttar Pradesh (Kanpur Nagar)	4,167,999	2,247,216	1,920,783	74.37	Total: 685,809 Chamar etc.: 304,424 Kori : 95,008 Pasi : 89,895	Total : 2, 051 Tharu : 1,248 Generic Tribes : 433 Buksa : 237
Uttar Pradesh (Kanpur Dehat)	1,563,336	844,339	718,997	66.44	Total: 388,419 Chamar etc.: 234,591 Kori : 44,780 Dhanuk : 37,732	Total : 382 Tharu : 267 Generic Tribes : 111 Raji : 4
Uttar Pradesh (Allahabad)	4, 936,105	2, 626,448	2, 309,657	62.11	Total: 1,065,097 Pasi etc.: 412,466 Chamar etc.: 402,347 Kol: 106,164	Total: 4, 273 Generic Tribes: 3,322 Tharu: 870 Jaunsari: 57

Source: Indian Census data 2001

Appendix 11b

Appendix 11b. State-wise details of the social, cultural and economic significance of river Ganga (Source: various secondary sources)

State	General Information	Social and Cultural Significance	Economic Significance
Jharkhand	▪ It has 18 districts: Garhwa, Palamau, Lohardaga, Chatra, Hazaribagh, Kodarma, Bokaro, Giridih, Deogarh, Dhanbad, Dumka, Pakaur, Godda, Sahibganj, Ranchi Gumia, West Singhbhum, East Singhbhum ▪ In Jharkhand, the river passes through Sahibganj and Rajmahal. ▪ More than 80 km of the river Ganga flows through Jharkhand. ▪ Wastes generated by towns in Sahibganj, cremation of bodies on the riverbank, industrial and mining waste are the major polluters. ▪ While the population of Sahibganj is about five lakh, that of Raj Mahal is about 50,000.	▪ Ganga played a very important role in the formation of the very structure of Jharkhand. It can be said to be the very source of the riverine civilization that grew around the Gangetic plains. Ganga divides, what was previously, Bihar into two clear halves. The Southern part became Jharkhand as the Northern part remained Bihar. Because of the fertile lands that it creates through its silt deposits, Ganga in Jharkhand is appropriately revered and respected by the inhabitants of the state ▪ Jharkhand is located right in the lap of Ganga, which girdles the state in its course. Almost all the major towns of Jharkhand are located beside the Ganga. The districts that are lined by the Ganga in its course are Sahebganj, Bokaro and Hazaribagh. Almost all the places of agricultural and industrial importance in Jharkhand have Ganga in its background. In Jharkhand, Ganga is not only the most important river but also the most important formative influence behind the entire composition of the state.	▪ Ganga of Jharkhand is intrinsically linked to the economy of the state. It provides the necessary silt in much of the land around it, increasing its fertility. Paddy is the greatest crop of the region. Therefore, the significance of Ganga in the state increases manifold. Many towns in Jharkhand are primarily industrial. Ganga provides the necessary infrastructure for the factories to perform. Thus, the importance of Ganga at Jharkhand cannot be fathomed. It is not surprising that the inhabitants consider Ganga as the reigning deity and worship it with all devotion and faith
Uttarakhand (Haridwar)	▪ The district is administratively subdivided into three tehsils i.e. Haridwar, Roorkee and Laksar and six development blocks i.e. Bhagwanpur, Roorkee, Narsan, Bahadrabad, Laksar and Khanpur. ▪ Important towns in the district are Haridwar, BHEL Ranipur, Roorkee, Manglaur, Dhandera, Jhabrera, Laksar,	▪ The city is associated as the Gateway to both Lord Shiva and Lord Vishnu, as 'Hardwar' and 'Haridwar' respectively. Haridwar is also rightfully called 'Gangadwar', as the holy river Ganga which flows down the Himalayas, enters the plains at Haridwar and spreads over the northern plains. ▪ It is among the seven sacred cities of Hindu culture in India. Hardiwar is also one of the	▪ Essentially a religious centre, Haridwar is also known as a centre of herbal medicine, and traditional studies at Gurukul Kangri and today, Haridwar is a bustling urban centre of the new state of Uttarakhand. Tourism industry is based on these festivals and religious importance of

	Landaura and Mohanpur Mohammadpur.	four venues in the country for the *Kumbh Mela* and Ardh *Kumbh Mela*, held every twelve and six years respectively. Haridwar is known for its temples, bathing ghats and tanks.	the holy Ganges at this pious site. Livelihood of many people depends on the tourist inflow in the city of Haridwar.
Uttar Pradesh	**Kanpur** ▪ Kanpur was divided into Kanpur Nagar and Kanpur dehat, 2 districts in 1977, reunited again in 1979 but again divided in 1981. The district Kanpur Dehat was renamed as Ramabai Nagar. ▪ Kanpur is also divisional hqrs. of Kanpur commissionary consisting of following districts: Kanpur-Nagar, Kanpur-Dehat, Etawah, Auraiya, Farrukhabad, Kannauj. **Allahabad** ▪ The city of Allahabad is among the largest cities of Uttar Pradesh and situated at the confluence of three rivers- Ganga, Yamuna and the invisible Saraswati. ▪ It has 8 tehsils, listed as following: Koraon, Soraon, Meja, Handia, PhulPur, Bara, Sadar, Karchhana. ▪ It has 20 blocks, listed as following: Kaurihaar, Kolagarh, Mauaima, Sohran, Baharia, Phulpur, Bahadurpur, Pratappur, Saidabad, Dhanupur, Handia, Jasra, Shankar Garh, Karchana, Urwa, Meja, Koraon, Manda	**Kanpur** ▪ Nestled on the banks of the river Ganga, Kanpur stands as one of North India's major industrial centres with its own historical, religious and commercial importance. ▪ Among the festivals of **Kanpur**, Ganga Mela is a unique festival that is played only in kanpur, 7 days after the festival Holi. ▪ The major polluting industries on the Ganga are the leather industries, especially near Kanpur, which use large amounts of Chromium and other toxic chemical waste, and much of it finds its way into the meager flow of the Ganga. People near the river bank have developed yellow spots all over their bodies **Allahabad** ▪ Sangam at **Allahabad** the holy confluence of the Ganga, Yamuna and the mythical Saraswati is revered by millions and is also the site for historic Mahakumbh held once every 12 years. The meeting point is known as Triveni and is especially sacred to Hindus.	
West Bengal	▪ West Bengal is now divided into nineteen districts under three divisions. ▪ The urban agglomeration of	▪ Ganga Sagar Mela, also known as Ganga Dussehra Mela is held in the month of January, on the occasion of Makar	▪ The Bhāgirathi-Hooghly river system is an essential lifeline for the people of West Bengal.

	Kolkata comprises 72 cities and 527 towns and villages.[47] The suburban areas of Kolkata metropolitan district incorporates parts of the districts North 24 Parganas, South 24 Parganas, Howrah, Hooghly and Nadia. ▪ The river Ganga was an important transportation channel in the early history of Bengal, and later with the colonial trading ports. The river's presence is one of the reasons chosen by the British to settle there at Calcutta. The Dutch/French colony at Chandannagar on the Hooghly was once the rival of British Calcutta, but was eclipsed by Calcutta in the colonial wars of the 18th century. The river banks hosted several battles and skirmishes towards the start of the colonial era, including the Battle of Plassey Palashi, as well as earlier wars against Maratha raiders. On eastern bank lie many historic and wealthy towns like Murshidabad, Jangipur and Ziaganj.	Sankranti at Sagardwip, about 105 km. south of Kolkata. Sagardwip is the island situated at the mouth of Ganga where the Hooghly river joins the sea. This is the largest fair of the West Bengal and celebrated for three days. On this day, a large number of Hindu pilgrims collect here and take bath in the holy waters and visit the Kapil Muni Temple. ▪ Like the rest of the Ganges, the Bhāgirathi-Hooghly is considered sacred to Hindus, and its water is considered holy. ▪ About 150 large industrial plants are lined up on the banks of the Hooghly River around Kolkata. Together, these plants contribute 30 percent of the total industrial effluent reaching the mouths of the Ganga. Of this, half comes from pulp and paper industries, which discharge a dark brown, oxygen-craving slurry of bark and wood fiber, mercury and other heavy metals which accumulate in fish tissues, and chemical toxins like bleaches and dyes, which produce dioxin and other persistent compounds. ▪ CNN-IBN-Outlook State of the Environment Poll has found that 77 per cent people have voted cleaning of rivers by government as the top priority. The findings are especially significant in Kolkata as its main river Hooghly is congested with solid waste and effluents. It is said that the character of a city is best judged by how well it maintains its sea or river front. ▪ Several bridges run over the Hooghly at Kolkata – Howrah Bridge, Vidyasagar Setu, Vivekananda Setu, Nivedita Setu (second Vivekananda Bridge), Jubilee	It is through this river that the East India Company sailed in to Bengal and established their trade settlement - Calcutta, which later grew up to be one of the greatest cities of the world and capital of the erstwhile British India. People from other countries like French, Dutch, Portuguese, etc. all had their trade settlement by the banks of this river. ▪ The river provides perennial supply of water to the plain of West Bengal for irrigation and human & industry consumption. The river is navigable and the major transport system in the region with a huge traffic flow. For a long time, the Calcutta Port was the biggest port of India. Though in the past its significance had gone down, but recently it had again came up to the 3rd position in the list of Indian Ports. The fish from the river are important to the local economy. ▪ The modern container port of Haldia, on the intersection of lower Hooghly and Haldi River, now carries much of the region's maritime trade. One new port will be built in the deep sea to reduce load on Calcutta port. Hooghly river valley was the most important industrial area of erstwhile state of Bengal. Due to declining jute industry, the prime industry of this region, it lost its glory and

		Bridge(chinsurah) and Iswar Gupta Setu (chinsurah).	partitioning of Bengal. But still it is one of the biggest industrial areas of India. Except Kolkata and Howrah it has number of small cities which forms the Greater Kolkata Agglomeration, the second biggest Indian city and former capital
Bihar (Patna)	▪ Patna district is one of the thirty-eight districts of Bihar state, with Patna as the district headquarters. Patna district is a part of Patna division Sub Divisions: (6 Nos) : Patna Sadar, Patna City, Barh, DanaPur, Masaurhi, Paliganj. Blocks: Patna Sadar, Phulwari sharif, Sampatchak, Fatuha, Khusrupur, Daniyawaan, Barh, Bakhtiarpur, Belchi, Athmalgola, Mokama, Pandarak, Ghoswari, Bihta, Maner, Danapur, Naubatpur, Masaurhi, Dhanarua, Punpun ▪ Bihar has a network of rivers. This is the most striking feature about the geography of Bihar. ▪ Among the rivers flowing through Bihar, the Ganges river is most dominant and is joined by the three mighty rivers, Ghagra, Gandak, and Sone. ▪ One of the most striking feature of the river system of Bihar is the dominant role of Ganga. The important rivers that join the Ganga from the north are, from west to east, Ghaghra, the Gandak, the Burhi Gandak, the Kosi, the Mahananda and its tributaries	▪ Chhath is an ancient Hindu festival dedicated to the worship of the Lord Sun and is mainly celebrated in the northeast region of India chiefly in Bihar, Madhya Pradesh, Uttar Pradesh, some parts of Chhattisgarh, Jharkhand on the banks of Ganga. It goes without mention that the river Ganges is one of the most important rivers of Jharkhand: the other rivers in Jharkhand flow as tributaries to the river Ganga. ▪ The river Ganga is a main source of electricity supply in the many parts of Bihar. ▪ Sonpur, which is situated along Ganga's bank in Bihar, is famous for the great bathing festival which is the occasion for the greatest cattle and elephant fair in the world Ganga is one of the major rivers of the Indian subcontinent, flowing east through the Gangetic Plain of northern India into Bangladesh. ▪ The river Ganga is of great importance to Bihar. Most of its streams flow through Bihar. It has a historical importance for Bihar. The Patliputra (now Patna), which is the state capital of Bihar has been located on its banks. Other cities are also located on its banks, such as Hazipur, Munger, etc. The Gange River’s basin drains 1,000,000sq km and supports	

		one of the world's highest density of humans. It support Bihar in agriculture, mostly. ▪ River Kosi also called the sorrow of Bihar is one of the largest tributaries of river Ganga. After flowing 58 km in Nepal, it enters the north Bihar plains near Bhimnagar and after another 260 km, flows into the Ganges near Kursela. The river travels a distance of 729 km from its source to the confluence with the Ganga. Kosi is prone to flood the Bihar region almost every year, hence this name “the sorrow of Bihar”.	