GOVERNMENT OF MAHARASHTRA
WATER RESOURCES DEPARTMENT

HYDROLOGY PROJECT (SW)

STATUS REPORT
ON WATER QUALITY OF WATER BODIES AND GROUND WATER IN MAHARASHTRA FOR THE YEAR 2004-2005

JANUARY 2007

Chief Engineer
Hydrology Project, Nashik

Status Report
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I N D E X

Preface

"Water" is a prime natural resource and is considered as a precious national asset. It is a major constituent of all living beings. Water is available in two basic forms i.e. Surface water and Ground water. Water is used for various purposes ranging from domestic, agricultural, industrial & allied purposes. The water quality criteria have been prepared by taking into consideration various designated uses. In order to assess the quality of water, various government agencies are working at National and State levels.

This report includes water quality data analysed in Maharashtra State by various National and State level agencies appointed by the committee under "Water Quality Assessment Authority". The data has been interpreted to know the affected locations. The report also includes details of water bodies, agencies analyzing water quality, legal aspects in terms of various Central and State government acts and standards specified for water quality assessment along with recommendations for maintaining the wholesomeness of surface as well as ground water. The list of references is attached at the end of report.

This Status Report is an outcome of keen interest shown by Er.V.V.Gaikwad, Secretary (WR) and Er.E.B.Patil, Secretary (CAD),Water Resources Department, Government of Maharashtra in the preparation of such document, which promoted the inspiration and enthusiasm needed for its preparation.

My sincere thanks to various State and Central level water quality assessing agencies and concerned authorities for getting analyzed and submitting necessary data from time to time. My special thanks to Water Quality Review Committee of State for inspiring me to have in the present form. I express my thanks to the officers of Hydrology Project (SW), Nashik compiling this report from various National & State level agencies.

I hope this report will play a vital role in creating awareness regarding water quality through-out the State and become important reference material for administrative and educational institutions.

This Status Report is submitted to the Chairman of Water Quality Review Committee, Government of Maharashtra for further needful. Suggestions thereof, if any, can be taken in to consideration while preparing next Status Report.

(H.T.Mendhegiri)
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CHAPTER – I

EXECUTIVE SUMMARY

Status Report on Water Quality of Water Bodies and ground water in Maharashtra

for the year 2004-2005

1.1 Preamble:

In exercise of powers conferred by sub sections (1) and (3) of section 3 of the Environment (Protection) Act, 1986 (29 of 1986), the central government constituted an authority to be known as "Water Quality Assessment Authority". This authority is empowered to draw action plans for quality improvement in water bodies and monitor and review/assess implementation of the schemes launched or to be launched, to review the status of quality of national water resources (both surface and ground water) and identify "Hot spots" for taking necessary action for improvement in water quality, to constitute/set up state level Water Quality Review Committee (WQRC) to coordinate the work to be assigned to such committees. The Water Quality Review Committee for Maharashtra was constituted on 01/01/2003 under the chairmanship of Secretary Water Resources Department In order to perform aforesaid task, a uniform protocol was formulated called as 'Uniform Protocol on Water Quality Monitoring Order, 2005' vide gazette notification dated 17th June 2005. The 4th meeting of State Level Water Quality Review Committee of Maharashtra State was held on 17/10/2005 at Mantralaya, Mumbai. During this meeting, it was suggested that data from all the participating agencies in Water Quality Review Committee may be analysed for the designated use of water prescribed in relevant BIS code, by the Chief Engineer Hydrology Project, Nashik and status report (titled as Status Report on Water Quality of Water Bodies in Maharashtra State) on analysis may be prepared for the year. Subsequently the historical data on water quality can also be analysed to observe trend of changes in water quality that has occurred to time to time. It was accordingly decided that water quality data of the year 2004-2005 will be sent by all participating agencies to the Chief Engineer (Hydrology Project) for preparation of status report.

1.2 Water:

An odourless, tasteless, colourless liquid formed by a combination of hydrogen and oxygen; forms streams, lakes, and seas, and is a major constituent of all living matter.

1.3 Water bodies:

The part of the earth's surface covered with water such as rivers, lakes, ponds, reservoirs and oceans etc. are described as water bodies.

1.4 Water is 'life'. It is one of the fundamental needs on the globe. Water is probably the only natural resource to touch all aspects of human civilization from agricultural and industrial development to cultural and religious values embedded in society.

1.5 The total water amount on the earth is about 1.35 billion cubic kilometers. About 97.1 % has been locked into oceans as saltwater. Ice sheets and glaciers have arrested 2.1 %. Only 0.2 % is the fresh water present on the earth, which can be used by human for variety of purposes. Remaining 0.6 % is in underground form. But unfortunately it has been getting polluted day by day due to different anthropogenic activities. So it is burning need, to conserve the water and prevent it from every type of pollution. There should be proper water quality investigation and management. This could be possible by continuous Water Quality Monitoring.

1.6 Ground water has been the primary source of water supply for domestic, agricultural and industrial uses in Maharashtra. It is the single largest and most readily available source of irrigation and more than 55% of the total area under irrigation depends on ground water sources. Nearly 70% of rural water supplies are based on ground water. Thus ground water plays a very important role in the state's economy and therefore needs to be monitored scientifically both in terms of quality and quantity, for sustainable development and management.

The entire geographical area of Maharashtra is occupied by 5 major river basins namely, Godavari, Krishna, Tapi, Narmada and West flowing rivers in Konkan coastal strip. About 75% area of Maharashtra is drained towards Eastern side, further joining with Bay of Bengal. The West flowing coastal rivers join the Arabian Sea.

The total surface water available for utilisation is 1,25,936 MCM

1.7 Water Quality Monitoring Agencies:

The Water Quality Monitoring is carried out by various agencies viz. Central Water Commission, Central Pollution Control Board, Maharashtra Jeevan Pradhikaran, Groundwater Surveys & Development Agency, Hydrology Project, Maharashtra Pollution Control Board, Central Ground Water Board, Directorate of Irrigation Research and Development (DIRD).

1.7.1 In Maharashtra, Hydrology Project of Water Resources Department, Government of Maharashtra is monitoring 127 stations for surface water (Baseline -50, Trend -65 and Flux - 12 nos.). Groundwater Surveys and Development Agency has monitored 1871 ground water stations. Central Ground Water Board has monitored 803 stations. Maharashtra Pollution Control Board is monitoring 73 stations for water (River - 45, Creek- 3 and 25 well water stations.). Central Water Commission has monitored river water quality at 12 stations. Total number of surface water monitoring stations is 187, whereas total number of ground water monitoring stations is 2699.

1.8 Water Quality Analysis for SW

The critical locations among the rivers Godavari, Tapi, Bhima, Krishna, Wardha, Wainganga and Ulhas are Takli (Nashik), on Godawari, Sukvad & Sarangkheda on Tapi Bundgarden (Pune), on Mula-Mutha, Pandharpur on Bhima ,Sangli on Krishna, Dhabha & Kamthikhairi on Wainganga and Manda Ulhas respectively considering the parameters namely pH, DO, BOD and Hardness. The maximum pH has been noted at Sarangkheda as 8.6. Dissolved Oxygen has noted minimum at Bundgarden as 1.2 mg/L. BOD and Hardness are found to be maximum at Manda as 71.7 mg/L and 1138 mg/L respectively.

Water Quality monitored during period January 2005 to September 2005, shows that pH is maximum (8.6) at village Ajanad on Tapi River. Average BOD is maximum (22.9 mg/L) at Mahim Creek on Mahim Bay. Average DO is least (3 mg/L) at Mahim Creek. Average Coliform density is maximum (2878 MPN/100 ml) at Nanded on Godavari River.

1.9 Water Quality Analysis for GW

Ground water samples were collected from 1871 wells during January – December 2004. After analysis, the following conclusions are drawn:

The maximum pH has been noted at village Ajnale (taluka Sangola, dist Solapur), Yellur

(taluka Walva, dist Sangli), Palaspur (taluka Himayatnagar, dist Nanded) as 10.2. The maximum TDS is 6528 mg/L at village Hirapur, taluka Georai from Beed district. Total Hardness is found to be maximum as 2720 mg/L at village Pujarwadi, taluka Atpadi from Sangli district. The maximum alkalinity is noted at village Pangaon, taluka Barshi from Solapur district as 1000 mg/L. Calcium has been found to be maximum at village Pujarwadi, taluka Atpadi from Sangli district as 944 mg/L. The maximum Sodium is 1530 mg/L at village Shinganapur, taluka Daryapur from Amravati district. The iron concentration is noted maximum at village Sonawade, taluka Kudal from Sindhudurga district as 6.1 mg/L. Total 54 well water samples have iron concentration more than 1.0 mg/L. Chloride is noted maximum at village Shinganapur, taluka Daryapur from Amravati district as 2673 mg/L. The maximum Sulphate is noted at village Kalkhed, taluka Shegaon from Buldhana district as 1848 mg/L. The nitrate is maximum at village Muthad, taluka Bhokardan from Jalna district 239 mg/L, which is 9 times greater than BIS standards. Total 319 well water sources have exceeded the BIS prescribed limit. Fluoride is found to be maximum at village Mop, taluka Risod from Washim district as 6.0 mg/L. Total 56 well water samples have fluoride concentration more than 1.5 mg/L

Ground water quality monitoring was carried at 1005 stations spread all over Maharashtra. From the data it is concluded that:

The electrical conductivity is found to maximum at village Akola from Akola district as 6200 µmhos/cm. The maximum TDS has been noted at village Manjur from Ahmednagar district as 3920 mg/L. Total Hardness is maximum at village Shegaon from Buldhana district as 2305 mg/L. Calcium is found to be maximum at village Jafrabad from Jalna district as 680 mg/L. The maximum Magnesium is noted at village Sadawan Bk. from Jalgaon district as 333 mg/L. The maximum Sodium is noted at village Bhatkulijain from Amravati district as 1052 mg/L. Potassium has been found to be maximum at village Kukadgaon from Osmanabad district as 323 mg/L. The maximum Chloride is noted as 1911 mg/L at village Dapoli from Raigad district. Sulphate is found to be maximum at village Manjur from Ahmednagar district as 1771 mg/L. The maximum Nitrate is found at village Sadawan Bk from Jalgaon district as 899 mg/L. Fluoride concentration has found to be maximum at village Daodipar Khapa from Bhandara district as 4.2 mg/L.

1.10 Recommendations/Remedial Measures:

1.10.1 Qualitative/Technical:

- Domestic effluents may be treated and disinfected before discharging.
- Effluents from the non-point sources may be identified. These are required to be collected and treated.
- The artificial recharge of ground water through integrated watershed management programme and rainwater harvesting will help to improve the ground water quality in the area where the problem exists.

1.10.2 Administrative:

- Non-industrial activities such as Effluent Treatment Plants, Composting, Vermiculture, Animal stalls, Cattle and Goat pens, Animal husbandry, Fish farming, Dumping of ash, Solid waste may not be allowed in 'No Development Zone' (3 km on either side of river) of A-I stretch of river. (source to first dam)
- No industries may be allowed in 'No Development Zone'. Industries are to be set up at distances specified by Pollution Control Board. River policy criteria (MPCB) may to be fulfilled.
- Measures for sustainable use of water resource are necessary.
- Farmers in the catchment area shall be educated against use of extensive amount of pesticides and chemical fertilizers. They shall be encouraged to use organic manure.
- Besides the regular ground water quality monitoring, special studies shall be undertaken on micro-level basis where ground water quality has undergone deterioration to ascertain the reasons, extent and remedial measures thereafter.
- The lack of facilities and awareness for proper disposal of waste and wastewater is mainly causing the ground water quality deterioration in the state. Hence, it is suggested that people in the rural and urban parts of the state should be made aware about the pollution of the ground water and its impacts. Strict regulations must be observed to stop pollution of ground water.
- Farmers may be encouraged to use advanced irrigation system like drip irrigation in order to conserve water and prevent erosion of top soil.

1.10.3 Legal:

- Environmental Impact Assessment studies shall be carry out for of all developmental projects right from planning stage and integrate it with their cost benefit considerations.
- Legislative measures are must to check over exploitation of ground water for various uses.

1.11 Suggestions:

- Create mass awareness in general public regarding surface and ground water quality aspects.
- Water quality status report shall be publicly published every year.

CHAPTER – II

INTRODUCTION

2.00 General

In exercise of powers conferred by sub sections (1) and (3) of section 3 of the Environment (Protection) Act, 1986 (29 of 1986), the central government constituted an authority to be known as "Water Quality Assessment Authority". This authority is empowered to draw action plans for quality improvement in water bodies and monitor and review/assess implementation of the schemes launched or to be launched, to review the status of quality of national water resources (both surface and ground water) and identify "Hot spots" for taking necessary action for improvement in water quality, to constitute/set up state level Water Quality Review Committee (WQRC) to coordinate the work to be assigned to such committees. The Water Quality Review Committee for Maharashtra was constituted on 01/01/2003 under the chairmanship of Secretary Water Resources Department In order to perform aforesaid task, a uniform protocol was formulated called as 'Uniform Protocol on Water Quality Monitoring Order, 2005' vide gazette notification dated 17th June 2005. The 4th meeting of State Level Water Quality Review Committee of Maharashtra State was held on 17/10/2005 at Mantralaya, Mumbai. During this meeting, it was suggested that data from all the participating agencies in Water Quality Review Committee may be analysed for the designated use of water prescribed in relevant BIS code, by the Chief Engineer Hydrology Project, Nashik and status report (titled as Status Report on Water Quality of Water Bodies in Maharashtra State) on analysis may be prepared for the year 2004-2005. Subsequently the historical data on water quality can also be analysed to observe trend of changes in water quality that has occurred to time to time. It was accordingly decided that water quality data of the year 2004-2005 would be sent by all participating agencies to the Chief Engineer (Hydrology Project) for preparation of status report.

Water is 'life'. It is one of the fundamental needs on the globe. Water is essential for variety of purposes to human beings as well as to plants and animals. Its many uses include drinking and other domestic uses, irrigation, power generation, transportation, industrial cooling, fishing, mining and fire fighting etc.

Water is probably the only natural resource to touch all aspects of human civilization from agricultural and industrial development to cultural and religious values embedded in society.

'Water Quality' term is generally used to express the physical, chemical or biological state of water. This in turn, may be related to the suitability of water for a particular use or purpose.

The quality of water is characterized by a range of physical, chemical and biological parameters, which arise from a variety of natural and human influences. Normally field or laboratory analysis of water is carried out for determination of its quality.

Normally water is never pure in a chemical sense. It always contains impurities of various kinds dissolved as well as suspended. These include dissolved gases like CO_2, H_2S, NH_3 and N_2, dissolved minerals Ca, Mg and Na salts, suspended matter, clay, silt, sand and even microbes. The natural impurities in water are in very low concentration, which are derived from atmosphere and soil. These impurities do not pollute water and the same is potable.

Contamination of water is certainly one of the key issues, as it can prevent water from being used for its intended purpose. Contamination can enter the water bodies through one or more of the following ways:

- Direct point sources: Transfer of pollutants from municipal, industrial liquid waste disposal sites, from municipal and household hazardous waste and refuses disposal sites.
- Diffuse agricultural sources: Wash off and soil erosion from agricultural lands carrying materials applied during agricultural use, mainly fertilizers, herbicides and pesticides.
- Diffuse urban sources: Runoff from city streets, from horticultural, gardening and commercial activities in the urban environment and from industrial sites.

2.1 Necessity of Water Quality Monitoring

Earth is also called as ‘blue planet’ because 70 % area of it has been covered by water resource. The total water amount on the earth is about 1.35 billion cubic kilometers. About 97.1 % has been locked into oceans as saltwater. Ice sheets and glaciers have arrested 2.1 %. Only 0.2 % is the fresh water present on the earth, which can be used by human for variety of purposes. Remaining 0.6 % is in underground form.

But unfortunately it has been getting polluted day by day due to different anthropogenic activities. So it is burning need, to conserve the water and prevent it from every type of pollution. There should be proper water investigation and management. This could be possible by continuous Water Quality Monitoring.

Ground water use has grown spirally with population growth and agro industrial development during last two decades. More than 70% of the rural water supply schemes in

the state are based on ground water. Similarly, out of total irrigated area in the state, more than 55% area is irrigated by ground water. Thus ground water plays a very important role in the state's economy and therefore needs to be monitored scientifically both in terms of quality and quantity, for sustainable development and management.

In order to manage water as prime natural resource, a basic human need and a precious national asset and to maintain its wholesomeness by way of planning, development & pollution control, Govt. of India passed National Water Policy under the auspices of Ministry of Water Resources, Govt. of India New Delhi in April 2002.The policy included various facets viz. Need for a National Water Policy, Information system, Water resources planning, Institutional Mechanism, Water allocation priorities, Project planning, Ground water development, Drinking water, Irrigation, Resettlement & Rehabilitation, Financial & Physical sustainability, Participatory approach to Water Resources Management, Private sector participation, Water quality, Water zoning, Conservation of water, Flood control and Management, Land erosion by sea or river, Drought prone area development, Monitoring of projects, Water sharing / distribution amongst the states, Performance improvement, Maintenance and Modernisation, Safety of structures, Science & technology, Training &so on.

In pursuance of a directive contained in the National Water Policy 2002 and recommendations of the Maharashtra Water and Irrigation Commission, the Government announced the Maharashtra State Water Policy in July 2003. This path breaking policy will determine the manner in which the planning, development and management of water resources are going to be carried out during the coming 20 years. The state water policy provides for regularly monitoring of surfaces and ground water quality .

2.2 Legal status of water quality monitoring in Maharashtra State

In Maharashtra, water quality is monitored by various agencies namely Hydrology Project (SW), Groundwater Surveys & Development Agency (GSDA), Central Pollution Control Board (CPCB) through Maharashtra Pollution Control Board (MPCB), Central Water Commission (CWC), Central Ground Water Board (CGWB, NHNS) as per provisions made by "Water Quality Assessment Authority" constituted under sub sections (1) and (3) of section 3 of the Environment (Protection) Act, 1986 (29 of 1986).

CHAPTER – III

WATER BODIES AND WATER POLLUTION

3.1 Introduction

Water: An odourless, tasteless, colourless liquid formed by a combination of hydrogen and oxygen; forms streams, lakes, and seas, and is a major constituent of all living matter.

Water bodies: The part of the earth's surface covered with water such as rivers, lakes, ponds, reservoirs and oceans etc. are described as water bodies.

There are several transitional forms of water bodies. The most important transitional water bodies are:

- Flood plains: intermediate between lakes and rivers with seasonal variability.

- Reservoirs: intermediate between rivers and lakes depending upon seasonal pattern of operation in relation to the river discharges.

- Marshes: intermediate between lakes and phreatic aquifers.

- Alluvial and karstic aquifers: intermediate between rivers and ground water.

The hydrodynamic characteristics of each type of water body are highly dependent on the size of the water body and on the climatic conditions in the drainage basin.

Water Pollution: The addition of any substance to water, changes its physical, chemical and biological characteristics, which may produce harmful effect on human beings, animals and plants.

Water pollution has many sources, which are illustrated as follows:

- **Domestic sewage:** It refers to the waste water that is discarded from households. Also referred to as sanitary sewage, this is one of the major constituent of water pollution. Sewage contains a wide variety of dissolved and suspended impurities. The main organic materials are food and vegetable waste; plant nutrients come from chemical soaps, washing powders, etc. Domestic sewage is also very likely to contain disease-causing microbes.

- **Industrial effluents:** Wastewater from manufacturing or chemical processes in industries contributes to water pollution. Industrial waste water contains thousands of chemical compounds, which are very toxic; like heavy metals, producing very deleterious effect on aquatic life. It also affects humans, animals, plants and microbes. During the last fifty years, the number of industries in India has grown rapidly.

- **Agricultural runoff:** The use of land for agriculture and the practices followed in cultivation greatly affect the quality of groundwater. Intensive cultivation of crops causes chemicals from fertilizers (e.g. nitrate) and pesticides to seep into the groundwater, a process commonly known as leaching. Routine applications of fertilizers and pesticides for agriculture and indiscriminate disposal of industrial and domestic wastes are increasingly being recognized as significant sources of water pollution.

Effects of water pollution

The effects of water pollution are not only devastating to people but also to animals, fish, and birds. Polluted water is unsuitable for drinking, recreation, agriculture and industrial purposes. It diminishes the aesthetic quality of lakes and rivers. More seriously, contaminated water destroys aquatic life and reduces its reproductive ability. Eventually, it is a hazard to human health. Nobody can escape the effects of water pollution.

3.2 Water Pollution Related Phenomenon

Eutrophication: When fresh water is artificially supplemented with nutrients, it results in an abnormal increase in the growth of water plants. This is known as eutrophication. The discharge of waste from industries, agriculture and urban communities into water bodies generally stretches the biological capacities of aquatic systems. Chemical run-off from fields also adds nutrients to water. Excess nutrients cause the water body to become choked with organic substances and organisms. When organic matter exceeds the capacity of the micro-organisms in water that break down and recycle the organic matter, it encourages rapid growth, or blooms, of algae. When they die, the remains of the algae add to the organic wastes already in the water; eventually, the water becomes deficient in oxygen. Anaerobic organisms (those that do not require oxygen to live) then attack the organic wastes, releasing gases such as methane and hydrogen sulphide, which are harmful to the oxygen requiring (aerobic) forms of life. The result is a foul-smelling, waste-filled body of water.

Bioaccumulation and Biomagnification: The process of biomagnification and bioaccumulation are extremely important in the distribution of toxic substance in the fresh water ecosystem. The concentration of pollutants within the organism due to bioaccumulation and biomagnification depends on the duration of exposure of the organism to the contaminated environment and its tropic level in the food chain. Several fold increases in trace contaminant concentrations have been commonly observed in lakes and estuarine environments.

Acidification: One of the major issues related to freshwaters is acidification. This is associated with the deposition of rainwater and particulates enriched in mineral acids. Acidic water causes unpleasant effect on phytoplankton, zooplankton as well as on the whole aquatic life.

3.3 Surface Water

3.3.1 Rivers

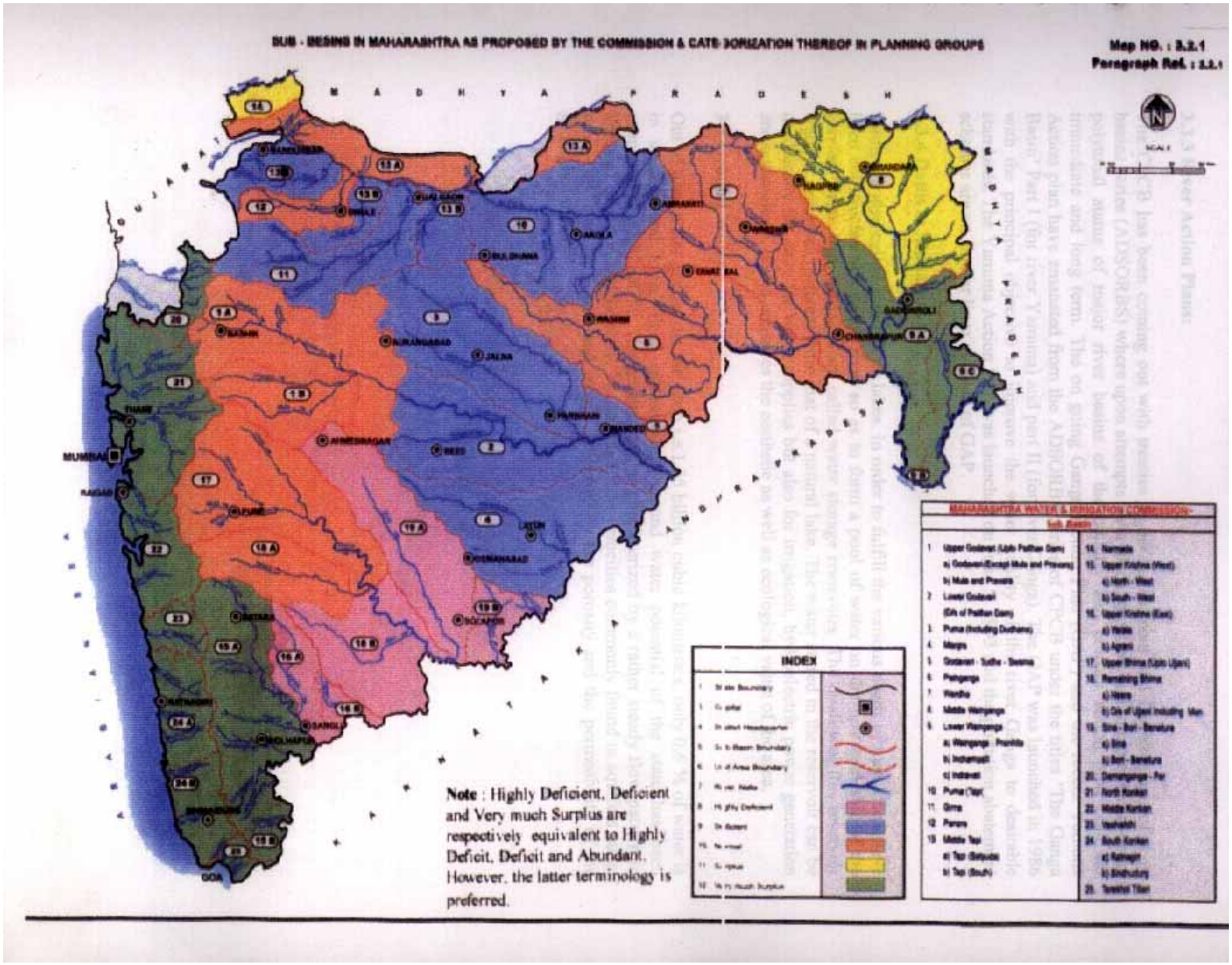
Water is life and rivers are lifelines. Fortunately almost the entire country is criss-crossed by rivers. There are thirteen major river basins in the country, which occupy 83 % of total drainage basins, contribute 85 % of total surface flow and house 80% of the country's population. They are Bramhaputra, Ganga, Indus, Godavari, Krishna, Narmada , Cauvery, Tapi, Pennar, Mahanadi, Brahmini & Baitarni, Sabarmati and Mahi. There are also eight other basins formed by grouping together a number of medium and minor basins. All the major river basins are not perennial. Only 4 of the 13 major basins possess areas of high rainfall i.e. Brahmaputra, Ganga, Mahanadi and Brahmini having annual average discharge of a minimum of 0.47 million cubic meter per km^2 and they are perennial. There are a few desert rivers, which flow for some distance and are lost in the desert.

3.3.2 River Basins in Maharashtra

Geographical area of the state is divided in five river basins viz. Godavari. Tapi, Narmada, Krishna and west flowing rivers in Konkan region**.**

The Maharashtra Water and Irrigation Commission (1999) has proposed delineation of five river basins basically into 25 distinct sub basins for planning of water resources development in the state. The sub basins are listed as below:

Sr. No.	River Basin	Names of Sub basins	
I	Godavari	1	Upper Godavari (Upto Paithan Dam)
		2	Lower Godavari (D.S of Paithan Dam)
		3	Purna (including Dudhana)
		4	Manjra
		5	Godavari - Sudha - Swarna
		6	Painganga
		7	Wardha
		8	Middle Wainganga
		9	Lower Wainganga
II	Tapi	10	Purna (Tapi)
		11	Girna
		12	Panzara
		13	Middle Tapi
III	Narmada	14	Narmada
IV	Krishna	15	Upper Krishna (West)
		16	Upper Krishna (East)
		17	Upper Bhima (Upto Ujjani)
		18	Remaining Bhima
		19	Sina - Bori - Benetura
V	West Flowing Rivers in Konkan	20	Damanganga-Par
		21	North Konkan
		22	Middle Konkan
		23	Vashisthi
		24	South Konkan
		25	Terekhol - Tillari


SUB - BESINS IN MAHARASHTRA AS PROPOSED BY THE COMMISSION & CATEGORIZATION THEREOF IN PLANNING GROUPS
Map NO. : 3.2.1
Paragraph Ref. : 3.2.1
MADHYA PRADESH
GUJARAT
KARNATAKA
ANDHRA PRADESH
GOA
MUMBAI
THANE
RAIGAD
PUNE
NASHIK
AHMEDNAGAR
AURANGABAD
JALNA
BEED
PARBHANI
NANDED
LATUR
OSMANABAD
SOLAPUR
SANGLI
SATARA
RATNAGIRI
SINDHUDURG
AKOLA
BULDHANA
AMRAVATI
YAVATMAL
WARDHA
NAGPUR
BHANDARA
GONDIA
GADCHIROLI
CHANDRAPUR
JALGAON
DHULE
NANDURBAR
INDEX
Note : Highly Deficient, Deficient and Very much Surplus are respectively equivalent to Highly Deficit, Deficit and Abundant. However, the latter terminology is preferred.
MAHARASHTRA WATER & IRRIGATION COMMISSION
Sub Basins
1 Upper Godavari (Upto Paithan Dam)
a) Godavari (Except Mula and Pravara)
b) Mula and Pravara
2 Lower Godavari
(Dn of Paithan Dam)
3. Purna (Including Dudhana)
4. Manjra
5. Godavari - Sudha - Sawana
6. Pangangа
7. Wardha
8. Middle Wainganga
9. Lower Wainganga
a) Wainganga - Pranhita
b) Indravati
c) Indravati
10 Purna (Tapi
11 Girna
12 Panjra
13 Middle Tapi
a) Tapi (Satpuda)
b) Tapi (South)
14. Narmada
15. Upper Krishna (West)
a) North - West
b) South - West
16. Upper Krishna (East)
a) Yerala
b) Agrani
17. Upper Bhima (Upto Ujani)
18. Remaining Bhima
a) Heera
b) Dis of Ujani including Man
19. Sina - Bori - Benatura
a) Sina
b) Bori - Benatura
20. Damanganga - Par
21. North Konkan
22. Middle Konkan
23. Vashishti
24. South Konkan
a) Ratnagiri
b) Sindhudurg
25. Terekhol Tillari

3.3.3 River Action Plans:

The CPCB has been coming out with treatise in the Assessment and Development of river basins series (ADSORBS) where upon attempts were made to collate and interpret basin – wise polytonal status of major river basins of the country and prepare action plan both for immediate and long term. The on going Ganga Action Plan (GAP) and the recent Yamuna Action plan have emanated from the ADSORBS series of CPCB under the titles 'The Ganga Basin' Part I (for river Yamuna) and part II (for river Ganga). The GAP was launched in 1986 with the principal objective to improve the water quality of the river Ganga to desirable standards. The Yamuna Action Plan was launched on June 5, 1993 and the pollution abatement schemes are on similar lines as those of GAP.

3.3.4 Dams in Maharashtra

Dams are also called as artificial lakes. In order to fulfill the various needs of man, dams have been constructed across the river so as to form a pool of water on the upstream side of the barrier. These artificial lakes are called water storage reservoirs. The quality of this reservoir water is not much different from that of a natural lake. The water stored in the reservoir can be used easily not only for water supplies but also for irrigation, hydroelectric power generation and aquaculture. It also enhances the aesthetic as well as ecological value of the area.

3.4 Ground Water

Out of total water present on the earth i.e.1.35 billion cubic kilometers, only 0.6 % of water is in underground form. Total replenishable ground water potential of the state has been estimated as 37.82 BCM. The groundwater is characterized by a rather steady flow pattern in terms of direction and velocity. The average flow velocities commonly found in aquifers range from 10^{-10} to 10^{-3} m/s and largely governed by the porosity and the permeability of the geological material.

CHAPTER – IV

INTEGRATED APPROACH FOR WATER QUALITY MONITORING

4.0 Water Authorities

In India, Water Quality Monitoring has been carried out historically for a number of reasons. Different organizations are operating networks to satisfy their objective such as:

4.1 Hydrology Project

National Hydrology Project was started in 1995 under the Ministry of Water Resources Govt. of India. The project was implemented in 9 Southern States with 6 central agencies.

♦Objectives of the Project (HP-I)

The aim of the Hydrology Project was to develop comprehensive, easily accessible and user friendly databases covering all aspects of Hydrological Cycle, including surface water and ground water in terms of quantity and quality and climatic measurements, particularly of rainfall involving complex web of inter-state and intra-governmental relationship. This will assist in development of more reliable spatially intensive data on water resources. The project further also aims at making the hydrological information available for planning and management of water resources and other legitimate uses and promoting its utilization. Achievement of these goals involved improvement of institutional and organizational arrangements, technical capabilities, and physical facilities available for collection, processing and dissemination of hydrological and hydro-meteorological information. The ultimate aim of the project was to deliver a functional Hydrological Information System (HIS) and improved institutional capacity to build, operate and utilize HIS to the benefit of the different user groups and to encourage cooperation among the different participating agencies through data exchange. The development of the databases would support major aspects of India's Water Policy, particularly with regards to water allocation and planning and management of water resources development at the National, State, Basin and Project level.

♦ Hydrology Project (HP- II)

The Project Development Objective (PDO) is to extend and promote the sustained and effective use of the HIS by all potential users concerned with water resources planning and management, both public and private, thereby contributing to improved productivity and cost-effectiveness of water-related investments in the 13 states and eight Central agencies. The coverage of existing states under the project is to help these agencies from moving over from development of HIS (as in HP-I) towards use of HIS in water resources planning and management. The PDO will be achieved by: (a) strengthening the capacity of hydrology departments (surface and groundwater) to develop and sustain the use of the HIS for hydrological designs and decision tools thus creating enabling environment for improved integrated water resources planning and management; (b) improving the capabilities of implementing agencies at state/central level in using HIS for efficient water resource planning and management, reducing vulnerability to floods and droughts and thereby meeting the country's poverty reduction objectives; (c) establishing and enhancing user-friendly, demand responsive and easily accessible HIS to improve shared vision and transparency of HIS between all users; and (d) improving access to the HIS by public agencies, civil society organizations and the private sector through awareness building supporting outreach services. Greater use of an improved HIS is expected to have a broad but definite impact on the planning and design of water resources schemes, from which the rural and urban poor will have secure and sustainable access to water for multi-purpose livelihood uses.

The Ministry of Water Resources (MoWR) Govt. of India is to implement, with assistance from the World Bank, the Hydrology Phase II Project, which will be a six-year project started from 05/04/2006. The project will involve: (i) the state surface water (SW) and groundwater (GW) agencies in the nine states covered by the recently-concluded first-phase project (HP-I) - Andhra Pradesh, Chhattisgarh, Gujarat, Kerala, Karnataka, Madhya Pradesh, Maharashtra, Orissa and Tamil Nadu; (ii) four new states Himachal Pradesh, Goa, Pondicherry and Punjab and Central agencies including MoWR, Central Water Commission (CWC), Central Groundwater Board (CGWB), National Institute of Hydrology (NIH), Central Water and Power Research Station (CWPRS), India Meteorological Department (IMD), Central Pollution Control Board (CPCB) and Bhakra- Beas Management Board (BBMB).

The project objective is to extend and promote the sustained and effective use of the Hydrological Information System (HIS) developed under HP I by all potential users concerned with water resources planning and management, both public and private.

This will be achieved by: (a) strengthening the capacity of hydrology departments (surface ad groundwater) to develop and sustain the use of the HIS for hydrological designs and decision tools; (b) improving the capabilities of implementing agencies at state/central level in using

HIS for efficient water resource planning and management to meet the country's poverty reduction objectives; (c) establishing and enhancing user-friendly, demand-responsive and easily-accessible HIS; and (d) improving access to the HIS by public agencies, civil society organizations and the private sector through supporting outreach services.

The project would consist of three main components: (i) Institutional strengthening, covering all 13 states and 8 central agencies; (ii) Vertical Extension, covering the existing nine states and six central agencies; and (iii) Horizontal Expansion, covering the four new states and two new -central agencies (CPCB and BBMB).

The first component, Institutional Strengthening, would comprise three sub-components: (i) consolidation of HP-I activities in the existing states; (ii) institutional support for awareness raising and knowledge dissemination; and (iii) implementation support. Under consolidation of HP-I activities, the project would support the existing Implementing Agencies (IAs) with continued/extended training in HIS data processing and new software as well as training in the use of specialized water quality (WQ) equipment. The project would also finance improved data processing, spatial analysis and dissemination of standard and user-specified maps, together with related capacity building. The awareness, dissemination and knowledge sharing sub-component would provide for management consultancy services to assist the HIS Coordination Secretariat (HISCS) with the formulation of a strategy and detailed operational proposals and implementation support for spreading awareness, dissemination and knowledge sharing among IAs and HIS users, and to train-IA personnel in these areas. Implementation support subcomponent would include consultancies to assist the HISCS and State-level IAs, and logistical support and incremental recurrent costs that include incremental staff and O&M cost. The Vertical extension component would include all those activities, which increase and enhance the use of HIS data, including: (i) development of hydrological design aids; (ii) decision support systems; and (iii) purpose-driven studies. The development of hydrological design aids would use HIS for the

creation/development of standardized hydrological design aids using well-established, internationally- acceptable methodologies.

These design aids would not only facilitate and expedite hydrologic designs but could also, for example, assist in the hydrological assessment of un-gauged catchments. Decision support systems (DSS), consisting of information systems linked to appropriate models, would also aim to promote the use of the data generated under HIS and would include:

(i) water resources planning and base operational DSS for all existing states and central agencies; (ii) a real-time flood management an advanced operational DSS for BBMB; and he project would also enable IAs to undertake purpose- driven studies covering such topics as SW or GW assessment, artificial recharge and specific WQ problems. All sub-components would be supported by the provision of spatial data and inputs and data visualization.

The Horizontal expansion component would broadly extend HP I activities to the four new states through: (i) upgrading/establishment of state data collection networks; (ii) establishment of data processing and management systems; (iii) implementation of purpose-driven studies; and (iv) staff and HIS user training.

The institutional and implementation arrangements for HP-Il would be mostly similar to HP-I and it is not foreseen that major changes in organizational structure will be required. Thus, overall responsibility for the project would rest with MoWR and, at central level, the existing National Level Steering Committee (NLSC) would continue as the apex body responsible for overall administrative and management coordination. This would be chaired by the Secretary, MoWR, and members would include senior representatives of all participating central agencies, chair-persons of the participating States Levels Steering Committee (SLSC). NLSC would meet twice a year, would monitor HP-Il at the national level and would provide strategic and policy direction.

The NLSC would be supported by three HIS Management Groups (HISMGs), comprising representatives of the IAs and focusing, respectively, on data use and dissemination (HISMGDD), institutional strengthening and training (HISMG-IS) and technical (HISMG-Tech.) aspects. Each HISMG would be empowered to constitute special Task Forces to address specific problem areas, as they arise, and would review project progress and

monitoring results for reporting to the NLSC. The HISCS would be the central nodal management structure responsible for overall project monitoring and coordination, and for collating the IAs' annual work and training programs for agreement with the Bank at annual reviews. It would be under the administrative control of MoWR, headed by a Commissioner, supported by a team of duly- strengthened, full-time, staff from MoWR or drawn from the participating central agencies of MoWR (to start with) and adequate administrative and infrastructure facilities. The team would include three Director-level staff, who would also serve as Member-Secretaries of the HISMGs, as well as a finance/budget officer. The HISCS would function as the secretariat for the NLSC and the HISMGs and would be assisted, on a fulltime basis, by a TA team for both technical and management aspects, as well as short-term TA for assisting financial management and procurement.

In the nine existing states, arrangements already in place for HP-I would continue, while in the four new states similar structures would be developed. The current IAs would continue to be responsible for -implementing the project with state-level coordination undertaken through a State Level Steering Committee (SLSC) chaired by the Secretary, and State HIS Coordination Committee (SHISCC) chaired by the Engineer-in-Chief/Director of the concerned Irrigation or Water Resources Department. In the case of state IAs reporting to more than one Secretary, the Chair of HISCC will rotate annually. The SLSC would meet at least twice a year. Members of the SLSC and SHISCC would be drawn from the project IAs within the state, including a high-level representative of the Finance Department. Each state would nominate a state project coordinator, a training coordinator, and procurement officer for day-to-day liaison with the central agencies, facilitated by suitably strengthened electronic information exchange, a fully connected network and a computerized MIS. The longer-term aim is to lead to a situation whereby HIS-related activities are the responsibility of a single, consolidated SW and GW data center, under a Chief Engineer, thereby strengthening conjunctive water resources planning and management at the state/basin levels.

4.2 Groundwater Surveys & Development Agency (GSDA)

The Project agreement between World Bank, I.D.A. and Government of Maharashtra, required that the State should establish the Groundwater Agency, especially for the development of minor irrigation schemes based on groundwater. As per the agreement , the State Government has established the Groundwater Surveys & Development Agency (G.S.D.A.) during the year 1972.

The G.S.D.A. is engaged, since last 33 years, in the exploration, development and augmentation of groundwater resources in the State through various schemes. This mainly includes, drilling of bore wells/tube wells under Rural Water Supply Programme, rendering technical guidance under minor irrigation programme by locating suitable dug well sites, strengthening of groundwater sources by water conservation measures, artificial recharge projects for induced groundwater, specific studies related to the periodic status of groundwater availability, protecting the existing groundwater resources through technical assistance under Groundwater Act etc.

4.3 Central Pollution Control Board (CPCB) (SW + GW)

The Central Pollution Control Board (CPCB), statutory organization, was constituted in September 1974 under the Water (Prevention and Control of Pollution) Act, 1974. Further, CPCB was entrusted with the powers and functions under the Air (Prevention and Control of Pollution) Act, 1981.

It serves as a field formation and also provides technical services to the Ministry of Environment and Forests of the provisions of the Environment (Protection) Act, 1986. Principal functions of the CPCB, as spelt out in the Water (Prevention and Control of Pollution) Act, 1974, and the Air (Prevention and Control of Pollution) Act, 1981, (i) to promote cleanliness of streams and wells in different areas of the States by prevention, control and abatement of water pollution. (ii) to improve the quality of air and to prevent, control or abate air pollution in the country.

The parliament of India in its wisdom enacted the Water (Prevention and Control of Pollution) Act, 1974 with a view to maintaining and restoring wholesomeness of our water bodies. One of the mandates of CPCB is to collect, collate and disseminate technical and statistical data relating to water pollution. Hence Water Quality Monitoring (WQM) and Surveillance are of utmost importance.

4.4 Maharashtra Pollution Control Board (MPCB) (SW + GW)

For the rational planning of a water pollution control program, it is imperative to understand the nature and extent of pollution control required. To achieve this, GEMS/ MINARS program was initiated by MPCB.MPCB is executing GEMS/MINARS projects under National Water Quality Monitoring Program (NWMP) funded by CPCB. These projects were initiated in 1978 with 3 stations and increased to 38 stations by 1992. In 2004, 10 surface

water stations and in 2006, 25 Ground Water stations were added to the project. At present MPCB monitors 48 Surface water and 25 Ground Water locations – Total 73 Stations. The Monitoring network covers 45 Rivers, 3 Creeks and 25 ground water locations. Monitoring at these stations is done as per the Uniform Protocol for water quality monitoring prescribed by MoEF and CPCB.

Water samples are being analyzed for parameters consisting of 9 core parameters, 19 other physcio-chemical and bacteriological parameters apart from field observations. Besides this 9 trace metals and 15 pesticides are also analyzed for selected samples once in a year to assess the water quality.

4.5 Central Water Commission (CWC) (SW)

Central Water Commission is the premier technical organization in India in the field of Water Resources since 1945 and is presently functioning as an attached office of the Ministry of Water Resources. The Commission is charged with the general responsibilities of initiating, coordinating and furthering in consultation with the State Governments concerned, schemes for control, conservation and utilization of water resources throughout the country, for the purpose of Flood Control, Irrigation, Navigation, Drinking Water Supply and Water Power Development. CWC also undertakes the investigations, construction and execution of any such schemes as required.

Major Activities of CWC

Central Water Commission is involved in the following important activities in the Water Resources Sector:

-Preparation of national Perspective Plan& Basin wise master plan
- Surveys, investigations and designs of schemes for development of river valleys.
- Matters relating to inter-state water sharing/disputes.
- Application of Remote Sensing techniques in Water Resources Sector.
- Project Monitoring to ensure speedy implementation and timely completion.
- Detailed Hydrological Studies of Projects.
- Collection, Collation & Publishing of Hydrological, Hydro-meteorological, Sediment & Water Quality data.
- Flood Management & Development & Operation of Flood Forecasting System.
- Studies for safety aspects of existing dams, issuing related procedures.
- Coordination in Research and Development activities.

4.6 Central Ground Water Board (CGWB) (GW)

Under Ministry of Water Resources, Govt. of India, ground water investigation, exploration, development and management are being dealt by Central Ground Water Board. Regulation and control of ground water management is being done by Central Ground Water Authority. The results obtained from the investigation carried out by the Scientists of Central Ground Water Board are taken into consideration for ground water regulation and control.

First level (Systematic) surveys on 1:50,000 scales has been completed for the entire country by March, 1991.This has generated basic information on various hydrogeological parameters. Ground water being replenishable and dynamic in nature, it becomes essential to conduct periodic hydro geological studies (Reappraisal hydrogeological surveys) to assess the qualitative and quantitative changes in the ground water regime in time and space. Approximately 2-lakh sq. km. area in different parts of the country is covered under periodic studies every year. These studies help in reassessing changes in ground water scenario consequent to various development activities.

Photogeological and remote sensing data is extensively used for hydrogeological purpose viz. source finding to demarcate the area and sites suitable for ground water development. Areas remaining hitherto inaccessible have also been surveyed and these techniques have proved very useful in understanding ground water scenario on regional scale. Advanced surface geophysical methods are used as source finding techniques. In hard rock terrains, this technique has proved indispensable to decipher sub-surface saturated fractures or situations suitable for ground water occurrence. CGWB renders assistance to various urban, defense and public sector establishments to solve their immediate water supply problems by selecting suitable sites for construction of ground water abstraction structures. The Board has carried out detailed surveys in Lakshwadeep and Andaman and Nicobar Islands to delineate shallow fresh ground water lenses and deep ground water zones in an otherwise saline water environment. Central Ground Water Board has also helped the Rajiv Gandhi National Drinking Water Mission in identifying suitable ground water sources for drinking water supply.

4.7 Central Ground Water Authority (CGWA) (GW)

Central Ground Water Authority has been constituted under Section 3 (3) of the Environment (Protection) Act, 1986 to regulate and control development and management of ground water resources in the country.

Powers & Functions: The Authority has been conferred with the following powers:

- Exercise of powers under section 5 of the Environment (Protection) Act, 1986 for issuing directions and taking such measures in respect of all the matters referred to in sub-section (2) of section 3 of the said Act.
- To resort to penal provisions contained in sections 15 to 21 of the said Act.
- To regulate and control, management and development of ground water in the country and to issue necessary regulatory directions for the purpose.
- Exercise of powers under section 4 of the Environment (Protection) Act, 1986 for the appointment of officers.

4.8 Maharashtra Jeevan Pradhikaran (MJP) (SW + GW)

Maharashtra Jeevan Pradhikaran (MJP) is responsible for constructing water supply schemes costing more than Rs. 7.5 million. Funds for construction of these schemes are made available by GOM mainly as grants in aid. Over its evolution and more particularly in the last 25 years, the MJP has essentially grown as a design and construction organisation. The objectives of MJP do not encompass financial sustenance or operations and maintenance, despite their having to operate and maintain schemes that are not taken over by local bodies (Municipalities, Zilla Parishads or Village Panchayats). This organisation was the lead agency in the programme for making Maharashtra "tanker-free" by the year 2000, thus strengthening its momentum to seek more resources for construction of schemes. For administrative simplicity, schemes are designed using cost and population norms devised by the government. The MJP has a large staff, organised into six divisions across the state. Reorganisation in 1997 provided for the creation of new sub-divisions across the state.

CHAPTER - V

LEGAL FACETS

5.0 Control of Water Pollution:

In India, various legislations have been formulated by Ministry of Environment and Forest such as Water Act. 1974. (Control / & Prevention), The water Cess Act, 1977, The Environment (Protection) Act, 1986 and various acts related to water use described details as below.

5.1 Water (Prevention and Control of Pollution) Act, 1974

The basic objective of the Act is to maintain and restore the wholesomeness of our national aquatic resources by prevention and control of pollution. The Water Act, 1974 represented one of India's first attempts to deal comprehensively with environmental issue. Parliament adopted minor amendments to the Act in 1978 and revised the Act in 1988 to more closely conform to the provisions of the Environment (Protection) Act, 1986. Water is a State subject under the constitution. Consequently, the Water Act, a central law, was enacted under Article 252 (1) of the constitution, which empowers the Union Government to legislate in a field reserved for the states. All the states have approved implementation of the Water Act. The Water Act is comprehensive in its coverage, applying to streams, inland waters, subterranean waters and sea or tidal waters. Standards for the discharge of effluent or the quality of the receiving waters are not specified in the Act, but it enables state boards and Central Board to prescribe these standards.

The Act provides for a permit system or "Consent" procedure to prevent and control water pollution. The Act generally prohibits disposal of polluting matter in streams, wells and sewers or on land in excess of the standards established by the state boards. A person must obtain consent from the state pollution control board before establishing any industry, operation or process, any treatment and disposal system or any extension or addition to such a system which might result in the discharge of sewage or trade effluent into a stream well or sewer or onto land. The state pollution control board may cancel its consent by orders that specify the location, constructions and use of the outlet as well as the nature and composition of new discharges. The Act empowers a state pollution control board, upon thirty days notice to a polluter, to execute any work required under consent order, which has not been executed.

The board may recover the expenses for such work from the polluter. The Act gives the state pollution control boards the power of entry and inspection to carry out their functions. Moreover, a state board may take certain emergency measures if it determines that an accident or other unforeseen event has polluted a stream or well. These measures include removing the pollutants, mitigating the damage and assuming orders to the polluter prohibiting effluent discharges.

5.1.1 Pollution Control Boards

The Water Act establishes a Central and State Pollution Control Boards. The Central Board may advise the Central Government on water pollution issues; coordinate the activities of state pollution control boards, sponsor research relating to water pollution, and develop a comprehensive plan for the prevention and Control of Water Pollution. The Central Board was also performing functions of a state board for the Union territories till 1991. During 1991 these functions were transferred to the local administration of respective Union Territories. In conflicts between a state board and the Central Board, the Central Board prevails. Since 1982 the Central Board has been attached to the Department of Environment, Government of India.

The State Boards were established by the State Government under the provision of the Act to perform functions specified in the Act. The State Boards may plan comprehensive pollution abatement programmes and advise the State Government on water pollution issues. They also collaborate with Central Board, inspect sewage or trade effluent, grant consent for the discharge of the effluent, lay down and modify the standards, evolve economic methods of treatment and disposal of sewage and trade effluent, advise the State Government on location of industries, collect and disseminate the data in relation to pollution status in the State and prosecute the offenders under the provision of the Act.

5.1.2 Penal Provisions

The Act mainly employs a system of criminal sanction to discourage the polluters from polluting the watercourses. The penal provisions can be categorized into four classes:

- Penal provision for not providing information as required under the provision of the Act, is punishable with imprisonment upto three months or a fine upto ten thousand rupees or both.

- Penal provision for disposal of polluting matters in water bodies more than the prescribed limit in the consent order or providing new outlets without obtaining consent of the State Pollution Control Board is punishable with minimum imprisonment of one and a half year which may be extended up to six years. For repeating the above offence the penalties are enhanced.
- Penalty for continuing contravention of provisions of the Act is punishable with fine of rupees 5000 every day till compliance with the provisions of the Act.
- There is a provision of publishing name of the offender in the newspaper at the offenders cost.

The 1988 Amendment Act introduced a new section 33A which empowers State Boards to issue directions to any person, officer or authority, including orders to close, prohibit or regulate any industry, operation or process and to stop or regulate the supply of water, electricity or any other service. The State Boards can also apply to courts for prevention water pollution under section 33 of the Act. Under Section 41, the penalty for failure to comply with a court order under Section 33 or a direction from the board under section 33A is punishable by fines and imprisonment. The Amendment also increased the power of the Central Board relative to the State Boards. Under section 18 of the Act, the Central Government may determine that a state board has failed to comply with Central Board directions and that because of this failure an emergency has risen. The Central Government may then direct the Central Board to perform the function of the State Board.

5.2. The Water Cess Act, 1977

To strengthen the pollution control boards by providing money for equipment and technical personnel and to promote water conservation by recycling, Parliament adopted the Water Cess (Prevention and Control of Pollution) Act, 1977. The Act empowers the Central Government to impose a cess on water consumed by industries listed in schedule I of the Act. Specified industries and local authorities are subject to the cess if they use water for purposes listed in schedule II of the Act. The amendment bill to enhance the rate of cess charges, and to change the charges from water consumption to waste water discharges, was introduced in the Parliament recently.

5.3. Laying Down of Standards for Environmental Pollutants

The simplest administrative approach to regulate industrial pollution would be to promulgate

permissible limits for various pollution parameters on a general basis, make them binding on all discharges and prosecute and punish any offenders. Control of pollution at sources is the immediate short-term objective adopted by all the State Pollution Control Boards.

To control pollution at source the industries must know the extent up to which their effluent or emission must be treated/controlled so that they can discharge the treated effluent to receiving environment without significant effect. The cost of treatment should be such that the industry is able to take the burden. The Central Pollution Control Board has initiated evolving industry specific Minimum National Standards (MINAS) as early as in 1977-78. At present it has evolved effluent standards for 23 categories and emission standards for 21 categories of industries. The State Boards use these guidelines for necessary follow - up action. No State Board is permitted to relax the MINAS, if situation so demands; the State Boards may make them more stringent. These standards have been notified under Environmental (Protection) Act, 1986, by the Government of India.

5.4. The Environment (Protection) Act, 1986

In the wake of Bhopal gas tragedy, the Government of India enacted Environment (Protection) Act, 1986 under Article 253 of the constitution. The purpose of the Act is to implement the decisions of the United Nations Conference on the Human Environment of 1972, in so far as they relate to the protection and improvement of the human environment and the prevention of hazards to human beings, other living creatures, plants and property. The Act is an 'Umbrella' legislation designed to provide a framework for Central Government coordination of the activities of various central and state authorities established under previous laws such as Water Act and Air Act. The potential scope of the Act is broad with 'environment' which includes water, air and land and interrelationship, which exists among water, air, land, human beings, other creatures, plants, micro organisms and property.

Section 3(1) of the Act empowers the Center to take all such measures as it deems necessary or expedient for the purpose of protecting and improving the quality of the environment and preventing, controlling and abating environmental pollution. Central Government is authorized to set New National Standards for ambient quality of the environment and standards for controlling emissions and effluent discharges; to regulate industrial locations; to prescribe procedures for managing hazardous substances; to establish safeguard for preventing accidents; and to collect and disseminate information regarding environmental

pollution. The Environment (Protection) Act (EPA) was the first environmental statute to give the Central Government authority to issue direct written orders including orders to close, prohibit or regulate any industry, operation or process or to stop or regulate the supply of electricity, water or any other services (Section 5).

Other powers granted to the Central Government to ensure compliance with the Act include the power of entry for examination, testing of equipment and other purpose (Section 10) and power to take samples of air, water, soil or any other substance from any place for analysis (Section 11). The Act explicitly prohibits discharge of pollutants in excess of prescribed standards (Section 7). Persons responsible for discharges of pollutants in excess of prescribed standards must prevent or mitigate the pollution and must report the discharge to government authorities (Section 9, 1).

Penal Provisions: The Act provides for severe penalties.

- Any person who fails to comply with or contravenes any of the provisions of the Act, or the rules or directions issued under the Act shall be punished for each failure or contravention, with a prison term of upto 5 years or a fine upto Rs. 1 lakh or both.
- The Act imposes an additional fine upto Rs.5000 for every day of continuing violation (Section 15 (1). If a failure or contravention occurs for more than one year after the date of conviction an offender may be punished with a prison term, which may extend to seven years (Section 15 (2)).

The Act empowers the Central government to establish standards for the quality of the environment in its various aspects, including maximum allowable concentration of various environmental pollutants (including noise) for different areas. These standards could be based on ambient levels of pollutants sufficiently low to protect the public health and welfare. Emission or discharge standards for particular industries could be adjusted to ensure that such ambient levels are achieved. The Environment (Protection) Rules, 1986 allow the State or Central authorities to establish more stringent standards based on recipient system.

5.5. Maharashtra Water Supply and Sewerage Board Act, 1976

The Act establishes the constitution on the Maharashtra Water Supply and Sewerage Board (subsequently renamed the Maharashtra Jeevan Pradhikaran, MJP). The Act requires the Board to provide water and sewerage services to the State Government, local bodies and private institutions and individuals. The supply of water for domestic purposes is defined

broadly to include trade, manufacture or business, gardens, irrigation, building and road construction, animals, fountains, swimming baths, washing vehicles and watering streets. The Act requires the Board to fix the cost of water (in respect of either a volumetric charge or a fixed charge per connection) and the cost of disposal of wastewater. It also gives powers to the Board to disconnect services for, amongst other things, non-payment of charges. The Act provides powers to the State Government to transfer or depute government employees to the Board. It also defines the Board's accounting, financing and contracting arrangements.

5.6. Maharashtra Groundwater (Regulation for Drinking Water Purpose) Act, 1993

First published, after having received the assent of the Governor, in the "Maharashtra Government Gazette" on 16th August 1993.

An Act is to regulate the exploitation of ground water for the protection of public drinking water and sources and matter connected therewith and incidental thereto.

"Drinking water purposes" in relation to the use of water, means consumption or use of water by human population for drinking and for other domestic purposes and includes consumption of water for similar such relevant purposes for cattle;

"Domestic purposes" shall include consumption of use of water for cooking, bathing, washing, cleansing and other day-to-day activities.

"Groundwater" means water existing in an aquifer below the surface of the ground at any particular location regardless of the geological structure in which it is stationary or moving and includes all groundwater reservoirs;

"Over-exploited watershed" means a watershed where the estimated annual groundwater extraction is more than 85 per cent of the estimated average annual groundwater recharge, calculated in the prescribed manner, and declared as such under section 6;

"Public water-supply system" means the structures relating to a public drinking water source, including conveying pipelines, storage reservoir, stand-posts, cisterns, hand pump, power pump and all other materials connected thereto, through which water is supplied for drinking water purpose.

5.7. Constitution of Environmental Monitoring Committee

With a view to integrate the environmental concerns into water resources development, the Environmental Management Directorate was carved out in Central Water Commission during 1987. It is envisaged to be a link between the State authorities who are executing water resources projects and the Ministry of Environment & Forests who are vested with the powers of clearing the projects from environmental angle. A multidisciplinary Environmental Monitoring Committee (EMC) was constituted by the Ministry of Water Resources during February, 1990 for overseeing the implementation of environmental safeguards stipulated by the Ministry of Environment & Forests while clearing the Water Resources Projects. The Committee is headed by the Member (WP&P), CWC with Director (Environmental Management) as its Member Secretary. It comprises members from Ministries of Environment & Forests, Agriculture & Cooperation, Welfare and Water Resources besides Planning Commission. The Committee is entrusted with the work of review of the mechanism established by the project authorities to monitor the ecology of the project areas and to suggest additional compensatory measures/facilities wherever necessary. It is also required to bring to the notice of the Government important cases of default, which may lead to the review of project's clearance for the funding arrangement. The EMC initially selected 78 Water Resources Development Projects, cleared by the Ministry of Environment & Forests, for monitoring. These Projects are geographically well distributed over the country. However, due to the limited resources available with the Committee, it identified 10 projects for close monitoring, while the remaining 68 projects would be monitored by State Level Environmental Monitoring Committee and Project Level Environmental Management Committee of respective State/Project.

5.8. Indian National Committee on Hydraulic Research (INCH)

INCH is one of the five Indian National Committees (INCs) constituted by the Ministry of Water Resources to promote research work in the field of hydraulic structure and river hydraulics, environmental hydraulics, drainage and reclamation, coastal and estuarine hydraulics and hydraulic machinery, city water supply, ports and harbours. INCH is entrusted with the promotion and funding of research work in the above fields. Member (D&R) is the Chairman of this committee.

5.9. Indian National Committee on Hydrology (INCOH)

The Indian National Committee on Hydrology (INCOH) was constituted by the Ministry of Water Resources in the year 1982. It is an apex body with the responsibility of coordinating the various activities concerning hydrology in the country. The Chairman, Central Water Commission is the Chairman of the Committee with the members drawn from Central and State Governments as well as experts from the academic and research organizations besides a few members drawn from non-Governmental professional organisations. The committee gets a feed back from States and coordinates activities at State level through State co-ordinators. INCOH plays an active role for implementation of UNESCO sponsored International Hydrological Programme (IHP).

5.10. Indian National Committee on Irrigation and Drainage (INCID)

Indian National Committee on Irrigation and Drainage (INCID) was constituted in 1990 by Ministry of Water Resources. The Chairman, CWC is the Chairman of INCID and Member (WP&P) is one of its members. The secretariat of INCID is located at New Delhi. The INCID pursues the mission and activities of ICID in India. It also looks into the R&D activities in irrigation and drainage sectors.

5.11 Water Quality Assessment Authority: - Task Force

The Water Quality Assessment Authority (WQAA) has constituted a Task Force in exercise of powers conferred by sub-section (1) and (3) of Section 3 of the Environment (Protection) Act,1986 to recommend measures for optimum Water Quality Observation Network and coordinated data collection and dissemination system to assist the Water Quality Assessment Authority. The Task Force is constituted with the following members.

Chairman, Central Pollution Control Board	Chairman
Advisor, Ministry of Environment and Forests	Member
Sr. Joint Commissioner (GW&MI), Ministry of Water Resources	Member
Member (SA&M), Central Ground Water Board	Member
Chief Engineer(P&D),Central Water Commission	Member
Water Quality Expert	Member
Additional Director, Central Pollution Control Board	Member-Secretary

The terms of reference (TOR) of the Task Force are as follows:

Development of Water Quality data information system and recommend the steps for Co-ordination in collection, use and dissemination of data. Review of Water Quality Monitoring network and recommend optimum network for the country. Recommend system for Accreditation of Water Quality laboratories in the country.

5.11.1 First Meeting of Task Force

The first meeting of the task force constituted by Water Quality Assessment Authority under the Chairmanship of Dr. V. Rajagopalan, Chairman, Central Pollution Control Board, Delhi (CPCB) held on 28/11/2003.

5.11.2 Second Meeting of Task Force

The second meeting of the task force held on 31.03.2004 to discuss the draft report. The issue of water quality parameters and frequency to be adopted was deliberated in detail and it was decided to modify the parameters and frequency for optimum generation of data/information with available resources. The need of monitoring of micro-pollutants was suggested for States having high pesticides consumption and other States consuming relatively less pesticides in quantitative terms per hectare unit area under agriculture, based on criteria defined in the succeeding paras in the report. The rationalization and optimization of monitoring network being maintained by various agencies will be taken up under Hydrology Project Phase-II of the World Bank, however, the criteria for optimization and rationalization of monitoring networks is being incorporated in this report of the task force. The accreditation of laboratories of various agencies involved in water quality monitoring shall be done based on the guidelines prepared by CPCB for parameters incorporated for Surface Water and Ground Water Monitoring Programme. CPCB agreed to extend training to Central Ground Water Board (CGWB), Central Water Commission (CWC) and State Government Agencies (SGA) involved in Water Quality Monitoring Programme for surface water and ground water agencies for entry of water quality data on the Webpage of CPCB. It was also decided that in the Hydrological information system CPCB shall be nodal agency for maintaining the water quality data as per the mandate of WQAA.

The Water Quality Assessment Authority has so far performed the following tasks:

- Constituted the Expert Group for review of the present Water Quality Monitoring programme for formulating a monitoring protocol. The protocol has been finalized.

- Constituted the State Level Water Quality Review Committees to review the monitoring practices at the state level and to highlight the important state issues for consideration by the Authority. So far 33 States Level Committees have been constituted out of 35 States / UTs in the country .
- Co-ordination cell in MoWR has been created for servicing the Authority.

5.11.3 Expert Group:

An Expert Group on Water Quality Monitoring System was constituted under Water Quality Assessment Authority with a view to unifying and streamlining the widely varying Water Quality Monitoring Systems being followed at present by various Central and State agencies.

Some of the important recommendations of Expert Group for its uniform implementation are:

i. The recommended protocol identifies different types of stations both under surface and Ground water category viz. Baseline, Trend and Trend cum-Surveillance/impact for implementation. This categorization is based on the extent to which the water at site is polluted, the Baseline station being the least polluted by the human activity. Number of parameters and its frequency for monitoring differs at each type of stations.

ii. There is an urgent need for developing two referral laboratories, one with Central Water Commission and the other with Central Ground Board.

iii. Quality assurance test viz. analytical quality control test 'within laboratory' and 'inter-laboratory' must be performed by all laboratories for ensuring reliability in data generation.

5.11.4 Co-ordination Cell in MoWR

The co-ordination cell performs the following functions:

- To work as Secretariat for WQAA meetings.
- To work as Secretariat for WQ Monitoring Committee.

In the second meeting held on 14th May 2003 the Authority generally accepted and approved the report of the Expert Group, which is being subjected to scrutiny from technical and operational angle before Notification under Environment (Protection) Act, 1986.

Under the Water Quality Assessment Authority various Task Force/Groups have been constituted. These are:

1. A Water Quality Monitoring Committee has been constituted under the Chairmanship of Additional Secretary and Project Director, Ministry of Environment and Forests. This Committee assists the WQAA in its functions.

2. A Task Force chaired by the Chairman, CPCB has been constituted to deal with matter relating to coordination, use and dissemination of data, review of water quality monitoring network, accreditation of water quality laboratories. The Task Force has submitted its report.

3. A Working Group has been constituted with Member, Central Water Commission (CWC) as a Chairman. This group deals with issues relating to minimum flows in rivers.

CHAPTER – VI

WATER QUALITY MONITORING IN MAHARASHTRA

6.1 Introduction

The Water Quality Monitoring is carried out by various agencies viz. Central Water Commission (SW), Central Pollution Control Board (GW), Groundwater Surveys & Development Agency (GW), Hydrology Project (SW), Maharashtra Pollution Control Board, Central Ground Water Board & Directorate of Irrigation Research and Development(DIRD). Hydrology Project takes care of surface water quality through sampling points spread over the State throughout the year; DIRD monitors dug wells in the command area of major and medium Irrigation Projects. Ground Water Surveys and Development Agency also monitors the dug wells as well as ground water levels of the State intermittently.

Agency wise Water Quality Monitoring details:

Sr. no.	Name of the Water Quality monitoring agency	No. of Water Quality monitoring sites
	State Surface water monitoring Agencies	
1.	Water Resources Department, Hydrology Project (SW)	127
	State Ground water monitoring Agencies	
2.	Groundwater Surveys & Development Agency (GSDA)	1871
	Central Surface water monitoring Agencies	
3.	Central Pollution Control Board (CPCB) (SW) through Maharashtra Pollution Control Board (MPCB)	48
4.	Central Water Commission (SW)	12
	Central Ground water monitoring Agencies	
5.	Central Pollution Control Board (CPCB) (GW) through Maharashtra Pollution Control Board (MPCB)	25
6.	Central Ground Water Board (CGWB, NHNS) (GW)	803
	Total no. of stations for surface water	187
	Total no. of stations for ground water	2699

6.2 Water Quality Monitoring (SW) in Hydrology Project:

6.2.1 The Hydrology Project and HIS

Hydrology Project aims at establishing a Hydrological Information System (HIS) in the state and the HIS includes Water Quality Monitoring of Surface Water. The basic objectives for WQ Monitoring are:

a) Monitoring for establishing baseline water quality.
b) Observing trend in water quality changes.
c) Calculating of flux of water constituents of interest.
d) Control and management of water pollution.

Monitoring for establishing baseline water quality :

Water Quality Monitoring System (WQMS) is developed as per WQ network as below;

6.2.2 Distribution of 127 WQ sampling locations is done amongst 5 Level-Il laboratories located at different places i.e. Pune-25, Nashik-25, Nagpur-25, Aurangabad-20, and Kohapur-32.

The WQ sampling frequencies considered for initially three year based on type of station classification.

Sr.No.	Category	Frequency
1	Baseline 50 No.	Monthly one sample
2	Trend - 65 No.	Fortnightly one sample
3	Flux - 09 No.	Fortnightly one sample
4	Trend/Flux - 03 No.	Fortnightly one sample
	Total - 127 No	

6.2.3 The Water Quality monitoring is being carried out under Hydrology Project. Hydrology Project (SW), Maharashtra takes care of surface water quality monitoring through 127 sampling locations spread over the state throughout the year (last 3 to 4 years). In accordance with decision taken in 1st meeting of Water Quality Review Committee of State of Maharashtra, 'The Uniform Protocol' for Water 'Monitoring finalized by the Water Quality Assessment Authority formulated by the Ministry of Water Resources is made available to H.P(SW), Maharashtra.Hydrology Project (SW), Maharashtra has gone through the

recommendation given in protocol and considering needs of HP, (SW), Maharashtra some guidelines are designed and circulated to field offices. On the basis of this Protocol, it is suggested to finalize the criteria for classification of location as 'BASELINE', 'TREND',' FLUX'etc.after collection of data for three years so that further Water Quality Monitoring also be uniform all over and classification of location should be finalized on the basis of Uniform methods.

The WQ sampling location category & frequency of sampling designed for SW, Maharashtra.

WQ Sampling Location category	Sampling frequency up to first 3 years	After 3 years monitoring
Baseline 50 No.	Monthly one sample	Break for 3 years
Trend - 65 No.	Fortnightly one sample	After classification as 'Trend' monthly one sample
Flux - 09 No.	Fortnightly one sample	After classification as 'Flux' fortnightly one sample
Trend/Flux -03 No.	Fortnightly one sample	After classification as Trend/Flux fortnightly one sample.

Statement showing Frequency of Sampling & Parameters to be analyzed

Station	Sampling Frequency	Test Parameters	Remark
Baseline	Once in a month first 3 years	30 parameters for 1st sample 20 Parameters for remaining Sample	After 3 years monitoring break for 3 years
Baseline after 3 years break and classification as baseline stations	Once in 2 months	30 parameters for 1st sample 20 Parameters for remaining Sample	One year monitoring again break for 3 years.
Trend	Twice a month	--do--	Initially 3 year monitoring
Trend (after classification as trend)	Once in a month	-- do --	Continuous monitoring
Flux	Twice a month	-- do --	Initially 3 year monitoring
Flux (after classification as Flux)	Twice a month	-- do --	Continuous monitoring with flow measurements
Reservoir and lakes (treated as Trend)	Twice a month	32 parameters for 1st samples. 22 parameters for remaining sample	Continuous monitoring

Note: - The parameters to be analyzed as mentioned above are minimal requirement. This is not however restricted. Additional parameters are to be analyzed if desired or on the basis of geographical stations of locations or certain circumstances.

List of Parameters

Sr No.	Parameter 32	Parameter 30	Parameter 22	Parameter 20
1	Colour	Colour	Colour	Colour
2	Odour	Odour	Odour	Odour
3	Temperature	Temperature	Temperature	Temperature
4	pH	pH	pH	pH
5	Electric Conductivity	Electric Conductivity	Electric Conductivity	Electric Conductivity
6	Dissolved Oxygen	Dissolved Oxygen	Dissolved Oxygen	Dissolved Oxygen
7	Turbidity	Turbidity	Total Solids	Total Solids
8	Total Solids	Total Solids	Dissolved Solids	Dissolved Solids
9	Dissolved Solids	Dissolved Solids	NO_2	NO_2
10	Suspended Solids	Suspended Solids	NO_3	NO_3
11	NH_3-N	NH_3-N	B.O.D.	B.O.D.
12	NO_2	NO_2	C.O.D.	C.O.D.
13	NO_3	NO_3	Total Coliforms	Total Coliforms
14	Total Phosphorous	Total Phosphorous	Faecal Coliforms	Faecal Coliforms
15	B.O.D.	B.O.D.	Turbidity	Turbidity
16	C.O.D.	C.O.D.	NH_3-N	NH_3-N
17	Potassium K^+	Potassium K^+	Total Phosphorous	Total Phosphorous
18	Sodium (Na)	Sodium (Na)	Chloride (Cl)	Chloride (Cl)
19	Calcium (Ca)	Calcium (Ca)	Alkalinity	Alkalinity
20	Magnesium	Magnesium	Sodium	Sodium
21	Carbonate (CO_3)	Carbonate (CO_3)	Total KjeldhalNitrogen	

22	Bi-Carbonate(H CO3)	Bi-Carbonate (H CO3)	Chlorophyll	
23	Chloride (Cl)	Chloride (Cl)		
24	Sulphate (SO_4)	Sulphate (SO_4)		
25	Fluoride	Fluoride		
26	Boron	Boron		
27	Total Coliforms	Total Coliforms		
28	Faecal Coliforms	Faecal Coliforms		
29	Alkalinity	Alkalinity		
30	Total hardness	Total hardness		
31	Total Kjeldhal Nitrogen			
32	Chlorophyll			

It is also decided to monitor water quality testing of reservoirs, lakes considering separate issue & frequency of sampling for such locations are considered twice in a month continuously & parameters are to be analyzed 32 for the first sample in the water year (June to May) and 30 parameters for rest of the samples.

6.3 Groundwater Quality Monitoring BY CGWB:

6.3.1 Introduction:

The Central Ground Water Board is monitoring the ground water quality of Maharashtra State for the last three decades through its National Hydrograph Network Stations (NHNS). These stations mainly consist of dug wells representing shallow aquifer. The objectives behind the monitoring is to develop an overall picture of the ground water quality of the State in terms of its suitability for different purposes, contamination causes, geochemical changes and assessment of periodic changes in the ground water quality.

During the hydrological year 2004-05, the Board carried out the ground water quality monitoring of 1005 stations. The sampling of ground water was carried out in the month of May. Eight hundred three number of ground water samples were collected. The samples from rest of the hydrograph stations could not be collected, as ground water sources were found dry during the monitoring. The samples after collection were subjected for the analysis of various parameters in the Regional Chemical Laboratory of the Board at Nagpur. The parameters analysed include general parameters such as pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS) & Total Hardness (TH), major ions in ground water such as

Calcium (Ca), Magnesium (Mg), Sodium (Na), Potassium (K), Carbonate (CO_3), Bicarbonate (HCO_3), Chloride (Cl), and Sulphate (SO_4), and parameters of health significance such as Nitrate (NO_3) and Fluoride (F). The methods of sample collection, preservation, storage, transportation and analysis given in Manual of American Public Health Association (APHA) for the examination of Water and Wastewater (1985) were followed. The compilation, validation, computerization and interpretation of ground water quality data thus generated were carried out to develop the overall picture of ground water quality in the state.

District wise Collection of Ground Water Samples:

District	No. of Sample	District	No. of Sample	District	No. of Sample
Ahmednagar	16	Hingoli	06	Parbhani	08
Akola	19	Jalgaon	29	Pune	34
Aurangabad	08	Jalna	13	Raigad	26
Amravati	41	Kolhapur	34	Ratnagiri	38
Beed	19	Latur	22	Sangli	04
Bhandara	22	Mumbai	06	Satara	22
Buldhana	20	Nagpur	32	Sindhudurg	32
Chandrapur	40	Nanded	23	Sholapur	07
Dhule	22	Nandurbar	09	Thane	38
Gadchiroli	51	Nashik	27	Wardha	39
Gondia	23	Osmanabad	13	Washim	17
				Yavatmal	43
TOTAL (MAHARASHTRA): 803 SAMPLES					

6.3.2 Physico-chemical characteristics of Ground water in monitored stations of Maharashtra state:

The pH of the ground water samples is indicating that the ground water in Maharashtra State is mainly alkaline in nature. The ground water in almost all the districts of Maharashtra State are having pH more than 7.0 except few samples of Ratnagiri and Sindhudurg districts which were weakly acidic in nature. The over all range of the pH of ground water in Maharashtra is 6.1 to 8.7. The pH of ground water also indicates that the CO_2 dissolved in water exists mainly in the form of bicarbonate while it also appears as a carbonate ion in those samples where pH is more than 8.3. In natural conditions, the pH of ground water is usually found in

the range of 6.5 to 8.5. However, it may be low or high depending on the environment in which the ground water exists. The percolation of strongly acidic or alkaline effluent/wastewater from anthropogenic sources to ground water may alter the pH of ground water.

The measurement of electrical conductivity of water provides an indication of ion concentration in water. As the concentration of ions increases, the electrical conductivity and total dissolved solids (TDS) also increases. Both are interrelated as mostly inorganic substances are dissolved in ground water. The TDS is computed as sum of ion concentrations. It is also an important parameter to assess the quality of water as solids dissolved in the water may affect the quality of water adversely. The western portion of Maharashtra especially in western coastal tracts, the solids dissolved in the ground water is less than 500 mg/L except three samples of Raigad district. This is due to the physiographical, climatic and hydrogeological conditions existing in the area. The ground water gets minimum residence time in this area. The flushing of aquifer is regularly going on due to the heavy rainfall and steep gradient in the area. It is also seen from the figure that in the plain area of Maharashtra specially plain areas of western Maharashtra, Marathwada and parts of Vidarbha, the TDS of ground water lies mainly in the range of 500 – 2000 mg/L with some pockets having TDS more than 2000 mg/L. The high TDS in ground water of Madhya Maharashtra may be due to impact of several factors such as industrialisation, urbanization and irrigation in canal command areas on ground water. The increase in TDS in Marathwada region of Maharashtra may be due to high rate of evapotranspiration in the area as it falls under the rain scarcity zone. The high TDS was also found in parts of Vidarbha under Purna basin where inland salinity problem exists.

The total hardness (TH) is the sum of calcium and magnesium concentration expressed in terms of $CaCO_3$ in mg/L. The carbonate and bicarbonate salts of calcium and magnesium give temporary hardness to ground water while chloride and sulphate salts give permanent hardness. The dissolution of calcium and magnesium to such a high extent from geological sources is ruled out as basalts mainly cover this area. It may be coming into ground water from anthropogenic sources. However, the high TH in ground water of Purna basin area of Vidarbha may be due to the inland salinity problems.

As the major part of Maharashtra is covered by basalts, the possibility of chloride and sulphate in ground water from aquifer material is very low. The potability of ground water is less affected as far as chloride in ground water is concerned. The same is the case with sulphate.

Under natural geochemical condition, the nitrate rarely becomes a major ion in the ground water. But the nitrate content in the ground water of the state indicates that it has become a major ion in ground water in many cases and the potability of ground water is affected by it.

Excessive use of fertilizers and lack of facilities for proper disposal of domestic waste and wastewater and sewage in the urban and rural part of every district of the state is facilitating the percolation of nitrate to ground water. The concentrations of fluoride in ground water of Chandrapur, Nagpur and Nanded districts of the state is very high affecting the potability of water. The source of fluoride in ground water of these districts is purely geological, as the anthropogenic sources do not exist in these areas.

6.3.3 Suitability of Ground Water for Drinking Purpose:

The suitability of ground water for drinking purpose is determined keeping in view the effects of various chemical constituents in water on the biological system of human being. Though many ions are very essential for the growth of human, but when present in excess, have an adverse effect on human body. The standards proposed by the Bureau of Indian Standards (BIS) for drinking water (IS-10500-93) were used to decide the suitability of ground water of Maharashtra State for drinking purpose.

Classification of Ground Water Samples as per BIS Drinking Water Standards (IS: 10500-93 Revised 2003).

Parameters	Drinking water Standards (IS-10500-93)		Total No. of Samples	Samples (< DL)		Samples (DL-MPL)		Samples >MPL	
	Desirable Limit (DL)	Maximum Permissible Limit (MPL)		No.	%	No.	%	No.	%
TDS (mg/L)	500	2000	803	434	54.0	349	43.5	20	2.5
TH (mg/L)	300	600	803	372	46.3	321	40.0	110	13.7
Ca (mg/L)	75	200	803	507	63.1	263	32.8	33	4.1
Mg (mg/L)	30	100	803	364	45.3	386	48.1	53	6.6
Cl (mg/L)	250	1000	803	704	87.7	89	11.1	10	1.2
SO_4 (mg/L)	200	400	803	756	94.2	34	4.2	13	1.6
NO_3 (mg/L)	45	No relaxation	803	526	65.8	-	-	277	34.2
F (mg/L)	1.0	1.5	803	751	93.6	34	4.2	18	2.2

6.3.4 Classification of Ground Water for Irrigation Purpose:

The classification of ground water for irrigation purpose was carried out based on the U.S. Salinity diagram, which uses Electrical Conductivity (EC) and Sodium Absorption Ratio (SAR) of the water to decide the sodium and salinity hazard on soil if the water is used for irrigation.

6.3.5 Classification of Ground water for Irrigation based on SAR values

EC in µS/cm (Salinity Hazard)	No. of Samples (%)	SAR Value			
		No. of Samples			
		<10 (Low)	10-18 (Medium)	18-26 (High)	>26 (Very High)
<250 (Low)	80 (9.96 %)	80	-	-	-
250-750 (Medium)	240 (29.89 %)	240	-	-	-
750-2250 (High)	426 (53.05 %)	425	1	-	-
>2250 (Very High)	57 (7.10 %)	48	7	1	1
Total (%)	803	793 (98.75 %)	8 (0.99 %)	1 (0.12 %)	1 (0.12 %)

Based on above classification, it is observed that 98.75% of samples fall under the category of low sodium hazard while 29.89% and 53.05% of samples fall under the category of medium and high salinity hazard respectively. This shows that if this water is used for irrigation on soil, there is little danger of development of sodium exchangeable problem but the salts dissolved in the water may cause problems. Under such circumstances, proper irrigation, soil and crop management practices are required to use the water for irrigation purpose.

6.3.6 Classification of Ground Water Samples as per BIS Drinking Water Standards

Parameters	Drinking water Standards (IS-10500-93)		Total No. of Samples	Samples (< DL) No. %		Samples (DL-MPL) No. %		Samples >MPL No. %	
	Desirable Limit (DL)	Maximum Permissible Limit (MPL)							
TDS (mg/L)	500	2000	811	440	54.3	351	43.3	20	2.4
TH (mg/L)	300	600	811	378	46.6	323	39.8	110	13.6
Ca (mg/L)	75	200	811	515	63.5	263	32.4	33	4.1
Mg (mg/L)	30	100	811	370	45.6	388	47.8	53	6.6
Cl (mg/L)	250	1000	811	712	87.8	89	11.0	10	1.2
SO_4 (mg/L)	200	400	811	764	94.2	34	4.2	13	1.6
NO_3 (mg/L)	45	No relaxation	811	534	65.8	-	-	277	34.2
F (mg/L)	1.0	1.5	811	759	93.6	34	4.2	18	2.2

6.3.7 Geochemical Classification of Ground Water:

In Maharashtra, 80% of the area is covered with basaltic formation. In basaltic formation, the ground water is typically of Ca-HCO_3 type. The nine types of water proposed by Piper was found out from the chemical analysis of ground water samples collected from Maharashtra and U/T of Dadra & Nagar Haveli by calculating the combination of percentage of epm values of alkaline earth's (Ca^+ Mg), alkali metals (Na^+ K), weak acids ($CO_3{}^+HCO_3$) and strong acids (Cl^+SO_4) of each sample separately. These nine types of water under different aquifer formations is presented in table - and the distribution of 'Type of Water' in the ground water is shown in figure-

Aquifer wise type of water in Maharashtra and Dadra and Nagar Haveli

Type of water	Aquifer											Total	%
	BAS	ALV	GRT	GNS	LTR	SST	QTZ	SCH	SHL	LST	LAM		
Ca-Cl	39	2	10	6	4	1	-	-	-	1	-	63	7.77
Ca- HCO_3	282	8	26	27	19	14	2	-	-	-	-	378	46.61
Ca-HCO_3-Cl	3	-	-	1	1	-	-	-	-	-	-	5	0.62
Ca-Mg-HCO_3	3	1	-	1	-	-	-	-	-	-	-	5	0.62
Ca-Na-HCO_3	1	-	-	-	-	-	-	-	-	-	-	1	0.12
Ca-SO4	1	-	-	-	-	-	-	-	-	-	-	1	0.12
Mg-Cl	19	2	4	-	2	1	-	-	-	-	-	28	3.45
Mg- HCO_3	153	14	17	14	5	5	-	1	-	-	-	209	25.77
Mg-HCO_3-Cl	-	-	1	-	-	-	-	-	-	-	-	1	0.12
Na-Ca-HCO_3	1	-	-	-	-	-	-	-	-	-	-	1	0.12
Na-Cl	15	3	2	-	-	-	-	-	-	-	-	20	2.47
Na-HCO_3	63	10	8	5	1	5	-	1	1	-	1	95	11.71
Na-SO_4	3	-	1	-	-	-	-	-	-	-	-	4	0.49
Total	**583**	**40**	**69**	**54**	**32**	**26**	**2**	**2**	**1**	**1**	**1**	**811**	100 %

Abbreviations: BAS – Basalt; ALV – Alluvium; GRI – Granire; GNS – Gneiss; LTR – Laterite; SST – Sandstone; QTZ – Quartzite; SCH – Schist; SHL – Shale; LST – Limestone; LAM – Lameta

The perusal of above table and figure indicates that ground water is mostly dominated by the alkaline earth-weak acid i.e. Ca-HCO_3 in most of the part of the state and union territory. 46.61 % of ground water samples are Ca-HCO_3 type followed by Mg-HCO_3 and Na-HCO_3. As discussed above, the Ca-HCO_3 type of water is a peculiar characteristic of basaltic formation. However, the chloride type of water either mixed with alkaline earth's (Ca/Mg) or alkali metal (Na) cations, though its percentage is low, is really of high concern. It means that process of transformation in ground water is taking place bringing strongly acidic anions ($Cl+SO_4$) into the ground water, thus changing the type of water as well as deteriorating the ground water quality. These transformations may be because of industrial activities in some urban and industrial belts of Maharashtra. The most dangerous type of water i.e. Ca-Cl (7.77%), Ca-SO_4, Mg-Cl, Na-Cl and Na- SO_4 accounts only 14.4 % in the entire state.

The dominance of Ca-HCO_3 type of water is observed in different formations like basalt, alluvial, granite, gneiss, laterite and schist's. Besides this, other following observations could be made:

1. Alkaline earth's (Ca+Mg) and weak acids (CO_3+HCO_3) both exceeds alkali metals (Na+K) and strong acids ($Cl+SO_4$) in most of the samples and is dominated in the entire state irrespective of different geological formations.
2. Alkaline earth's exceeds alkali metals in and strong acids exceeds weak acids (Ca/Mg-Cl type of water) in 22 % of samples:
3. Alkali metal exceeds alkaline earth's & weak acids exceeds strong acids (Na-HCO3 type of water) in 4 % of samples;
4. Alkali metal exceeds alkaline earth's & strong acids exceeds weak acids (Na-Cl type of water) in only 2 % of samples.

The physico-chemical characteristic of ground water is due to the dissolved gases/ions in it from the atmosphere, soil strata and minerals and rocks with which it comes in contact. The concentration of CO_3^{--}, HCO_3^-, OH^- and H^+ ions and dissolved CO_2 gases decide the acidic or basic nature of water while the salts of ions like Ca^{++} and Mg^{++} in water makes it soft and hard. Water with high Na^+ and Cl^- concentration can make the water saline. Nitrate ions percolated from anthropogenic sources can become predominant major anion in groundwater. The dissolution of fluoride ions in groundwater from its minerals or rocks reaches its concentration in significant amount.

6.4 Groundwater Quality Monitoring by GSDA

6.4.1 Introduction

Groundwater is exploited in the State for domestic, livestock and irrigation purposes since earliest times. Its use has grown spirally with population growth and agro industrial development during the last two decades. More than 70% of the rural water supply schemes in the state are based on groundwater. Similarly, out of total irrigated area in the state, more than 55% area is irrigated by groundwater. Thus, groundwater plays a very important role in the State's economy & therefore needs to be monitored scientifically both in terms of quantity & quality, for its sustainable development & management. The National water policy also envisages creation of standardized, comprehensive, reliable & comprehendible national information system on water resources covering both surface & groundwater by establishing a network of purpose built groundwater quantity & quality monitoring stations.

6.4.2 Background

Groundwater Surveys & Development Agency was established as an independent organization in the year 1972, for planning, programming, exploration, assessment, development & management of Ground water resources of the state. The important aspect of assessment of Groundwater quality for various uses like drinking, irrigation & industry was felt to be a necessity & a State level water quality analytical laboratory was established at Pune in the year 1978. As the exploitation of groundwater grew consistently with the increase population & development of agro industrial sector, a need was felt to decentralize the water quality analytical laboratory. Accordingly, six regional water quality analytical laboratories were established at Pune, Nagpur, Amrawati, Nashik, Aurangabad & Kokan, and New Mumbai in the year 1987-1988. It has faciliated in the quick transport of the water samples & it's timely analysis & faster communication of results to district's Senior Geologist for appropriate action.

6.4.3 Groundwater Quality Monitoring

Under hydrology project, Groundwater quality monitoring network has been established. The following objectives were decided for groundwater Quality monitoring in the State.

- Identification of baseline conditions. This will provide background information on groundwater quality for studying natural process.

- To observe long term trends in groundwater quality. This will show trends of groundwater quality changes derived from natural causes and human (anthropogenic) activities.

- To find the suitability of groundwater for drinking & irrigation purposes.

- To observe and study the reasons of salinity in coastal area.
- To study the groundwater quality in irrigation command area and observe the extent of groundwater pollution due to agricultural activities.
- To identify and monitor the locations of major pollutant sources e.g. landfill sites, domestic sewage, industrial waste disposal and mining activities.
- Monitoring of nitrate, fluoride and iron concentration in groundwater and to identify fluoride, nitrate and iron vulnerable areas (Zones).
- To calibrate and validate groundwater quality models which may have been developed for pollution control, seawater intrusion, contaminant migration, prediction of nitrate trends.

After the due consideration of objectives the monitoring network for Maharashtra was designed and this is based on Hydrogeology, hydromorphology, water use & water quality issues. Groundwater quality monitoring network consist of three types of stations namely Baseline, Trend and Trend cum surveillance. In the state 3370 key wells were identified as baseline stations with density of approximately one station per 100km. These wells give comprehensive picture of the quality of the groundwater in the state. Out of these key wells, 975 i.e. 30% baseline stations were classified as Trend and Trend cum Surveillance stations. Presently only baseline monitoring work is carried out. Samples from 1871 observations wells were collected and analyzed during the year January-December 2004.

6.5 Water Quality Monitoring by CPCB

CPCB in collaboration with concerned SPCBs / PCCs established a nationwide network of water quality monitoring comprising 1019 stations in 27 States and 6 Union Territories. Out of 1019 stations, 73 stations are from Maharashtra covering 45 river stations, 3 from creeks and 25 well water samples. The monitoring is done on monthly or quarterly basis in surface waters and on half yearly basis in case of ground water.

Monitoring Stations under MINARS Projects- Ground Water

Sr.No	Station code	Type	Location	Latitude	Longitude	Water quality program	Monitoring frequency
1	1984	Bore well	Bore well at M/s Tata Iron &Steel Co.Ltd, S-76, (Indl.Estate,Tarapur), Village-MIDC, Tarapur Taluka- Palghar, District-Thane.	19° 47.233’	72° 43.851’	MINARS	H
2	1985	Dug well	Dug well at 5 -Star Industrial estate, Village-Kashimira Taluka-Mira-Bhayander District-Thane	19° 6.422’	72° 52.310’	MINARS	H
3	1986	Bore well	Bore well at Village-Motapada Taluka- Dahanu District- Thane	19° 41.185’	72° 45.887’	MINARS	H
4	1987	Bore well	Bore well Village-Gokhiware Taluka- Vasai District- Thane	19° 4.783’	72° 51.380’	MINARS	H
5	1988	Bore well	Bore well at Gharatwadi, Village- Aliyali Taluka- Palghar District- Thane	19° 41.183’	72° 45.924’	MINARS	H
6	1989	Bore well	Bore well at MWML site,Village-Karawla,Taloja Taluka- Panvel District- Raigad	19° 05.871’	73° 06.903’	MINARS	H
7	1990	Well	BMW Site,Burudgaon, Ahmednagar, Nashik			MINARS	H
8	1991	Well	MSW Site, Pathardi, Nashik			MINARS	H

Sr.No	Station code	Type	Location	Latitude	Longitude	Water quality program	Monitoring frequency
10	1993	Well	Phandarpur, Gangapur, Aurangabad			MINARS	H
11	1994	Well	TPS-Durgapur, Chandrapur			MINARS	H
12	1995	Well	Khaperkheda, Nagpur			MINARS	H
13	1996	Well	Koradi, Nagpur			MINARS	H
14	1997	Well	Raipur, Nagpur			MINARS	H
15	1998	Well	Bhahmni,Kalmeshwar, Nagpur			MINARS	H
16	1999	Well	Sangera, Gondia, Nagpur			MINARS	H
17	2000	Well	Bhandewari, Nagpur			MINARS	H
18	2001	Well	Sukali, Amravati			MINARS	H
19	2002	Well	Akot, Akola, Amravati			MINARS	H
20	2003	Well	Sawargaon,Yavatmal, Amravati			MINARS	H
21	2004	Well	Parvati Industrial Estate, Yadrav, Shirol, Kolhapur.			MINARS	H
22	2005	Well	Khanjirenagar, Ichalkaranji, Kolhapur			MINARS	H
23	2006	Well	MIDC, Shinoli, Chendgad, Kolhapur			MINARS	H
24	2007	Well	Savali, Sangli, Kolhapur			MINARS	H
25	2008	Well	Rasulwadi-Sambarwadi, Sangli, Kolhapur Chinchwad, Pune			MINARS	H

CHAPTER – VII

RESULTS AND CONCLUSIONS

7.1 Surface Water - Hydrology Project:

The following parameters are found to be maximum affected at the following locations:

pH:	Tapi River -	Sarangkheda	- 8.6
DO:	Bhima River -	Bundgarden	– 1.2 mg/L
BOD :	Ulhas River -	Manda	– 71.7 mg/L
Hardness:	Ulhas River -	Manda	– 1138 mg/L

7.1.1. Hot Spot River Godavari – Takli (Nashik)

Sr. No	Parameter	Tolerance Limit	Summer	Monsoon	Winter	Remarks
1	pH	6.50 to 8.50	7.50	7.6	7.50	OK
2	DO	> 6 mg/L	3.40	3.90	3.30	Worst
3	BOD	< 2 mg/L	39.3	34.0	25.80	Worst
4	Hardness	up to 300 mg/L	219	194	221	OK

The water quality at Takli (Nashik) is found to be worst with reference to DO and BOD whereas pH and Hardness are found within limit.

7.1.2. Hot Spot River Tapi – Sukvad and Sarangkheda

Sr. No	Parameter	Tolerance Limit	Location	Summer	Monsoon	Winter	Remarks
1	pH	6.50 to 8.50	Sarangkheda	8.60	8.20	8.10	Worst in summer
			Sukwad	8.4	8.20	8.0	Ok
2	DO	>6 mg/L	Sarangkheda	7.20	5.20	6.10	Worst in Monsoon
			Sukwad	8.10	5.30	5.90	Worst in Monsoon and marginally bad in winter
3	BOD	< 2 mg/L	Sarangkheda	21.1	49.8	24.0	Worst
			Sukwad	17.4	29.10	22.8	Worst
4	Hardness	Up to 300 mg/L	Sarangkheda	140	149	160	OK
			Sukwad	161	169	147	OK

The water quality at Sarangkheda and Sukwad is worst affected with reference to BOD. The DO at Sukwad is less than stipulated limit during monsoon and winter. pH at Sarangkheda is exceeding the limit. Hardness at both locations is within limit.

7.1.3. Hot Spot -River Mula-Mutha & Bhima – Bundgarden and Pandharpur respectively

Sr No	Parameter	Tolerance Limit	Location	Summer	Monsoon	Winter	Remarks
1	pH	6.50 to 8.50	Bundgarden	7.4	7.6	7.3	OK
			Pandharpur	8.10	8.00	7.9	OK
2	DO	>6 mg/L	Bundgarden	1.3	2.3	1.2	Worst
			Pandharpur	5.50	5.30	5.50	Worst
3	BOD	< 2 mg/L	Bundgarden	22	11.3	23.3	Worst
			Pandharpur	5.0	3.7	5.50	Worst
4	Hardness	Up to 300 mg/L	Bundgarden	147	143	152	OK
			Pandharpur	268	284	582	Worst in winter.

The water quality at Bundgarden and Pandharpur is worst affected w.r.t. DO and BOD. Hardness at Pandharpur is worst in winter.

7.1.4. Hot Spot River Krishna - Sangli

Sr. No	Parameter	Tolerance Limit	Summer	Monsoon	Winter	Remarks
1	pH	6.50 to 8.50	8.20	7.80	8.00	OK
2	DO	> 6 mg/L	5.0	5.40	5.60	Worst
3	BOD	< 2 mg/L	1.50	1.80	3.10	Worst in winter
4	Hardness	up to 300 mg/L	249	150	245	OK

The water quality at Sangli is worst affected w.r.t. DO. In winter BOD is exceeding the limit. Hardness and pH are found in limit.

7.1.5. Hot Spot River Wardha – Dhabha

Sr. No	Parameter	Tolerance Limit	Summer	Monsoon	Winter	Remarks
1	pH	6.50 to 8.50	8.6	8.1	8.3	Worst in summer
2	DO	> 6 mg/L	5.7	6.1	7.0	Worst in summer
3	BOD	< 2 mg/L	3.0	3.0	2.7	Worst
4	Hardness	up to 300 mg/L	208	176	188	OK

The water quality at Dhabha is worst affected in summer w.r.t. pH & DO. BOD is exceeding the limit whereas, Hardness is found within limit.

7.1.6. Hot Spot River Wainganga - Kamthikhairi

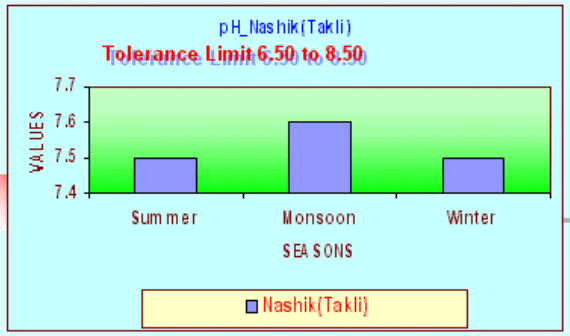
Sr. No	Parameter	Tolerance Limit	Summer	Monsoon	Winter	Remarks
1	pH	6.50 to 8.50	8.3	8.1	8.2	OK
2	DO	> 6 mg/L	6.1	6.7	7.3	OK
3	BOD	< 2 mg/L	1.9	2.9	3.0	Worst in monsoon & winter
4	Hardness	up to 300 mg/L	195	123	139	OK

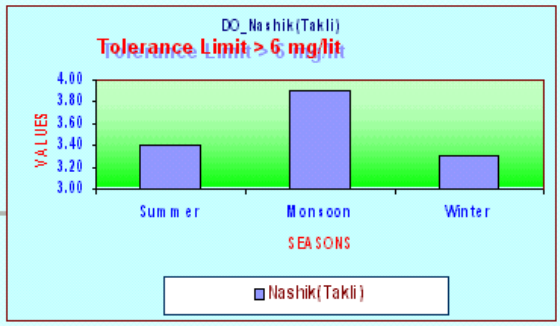
The water quality at Kamthikhairi is found worst in monsoon & winter with reference to BOD.

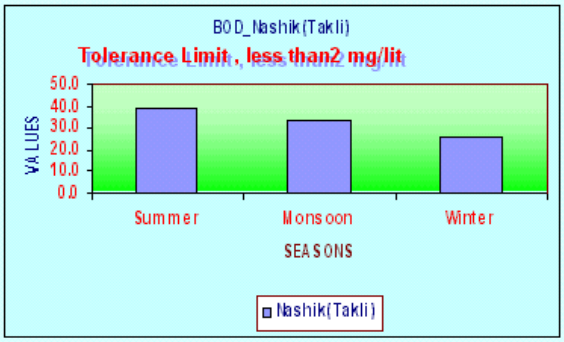
7.1.7. Hot Spot River Ulhas - Manda

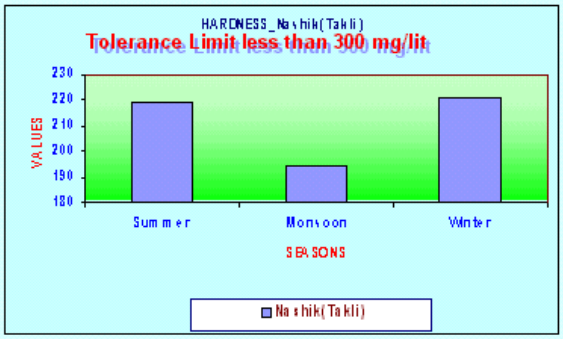
Sr. No	Parameter	Tolerance Limit	Summer	Monsoon	Winter	Remarks
1	pH	6.50 to 8.50	7.4	7.4	7.5	OK
2	DO	> 6 mg/L	2.9	3.7	3.5	Worst
3	BOD	< 2 mg/L	71.7	28.9	70.3	Worst
4	Hardness	up to 300 mg/L	1138	226	731	Worst in summer & winter

The water quality at Manda is worst affected w.r.t. DO & BOD. The hardness is extensively high in summer and winter.









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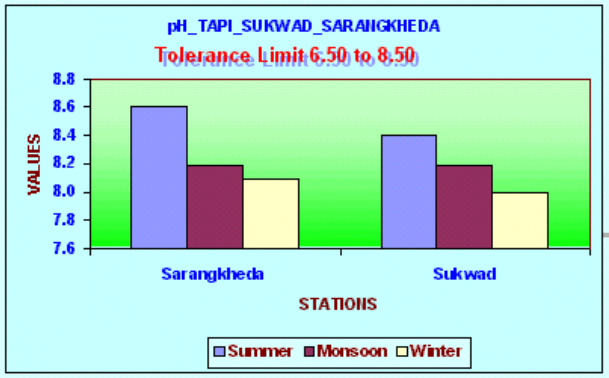

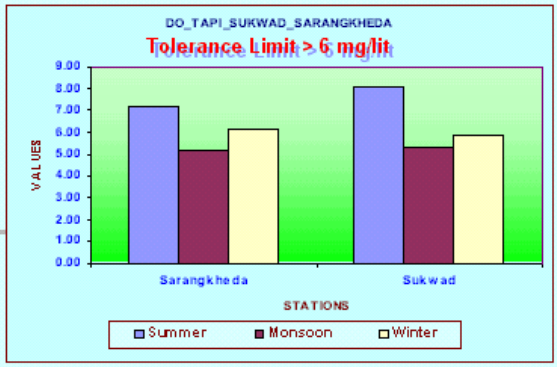

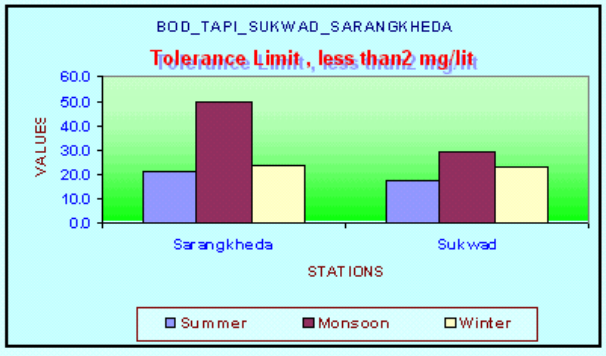

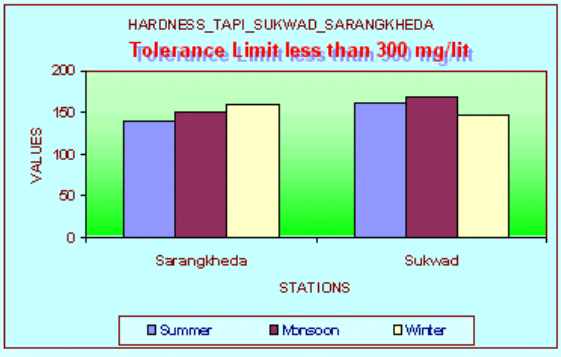

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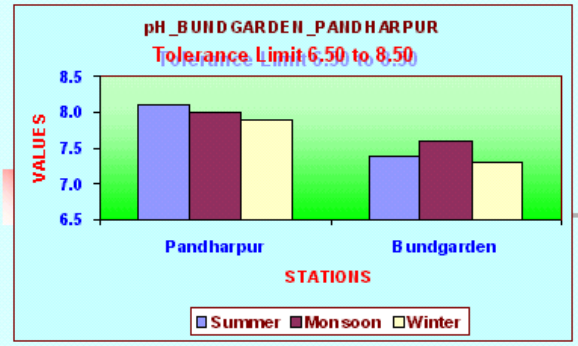

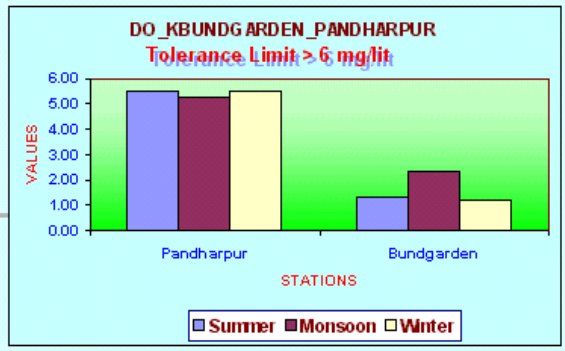

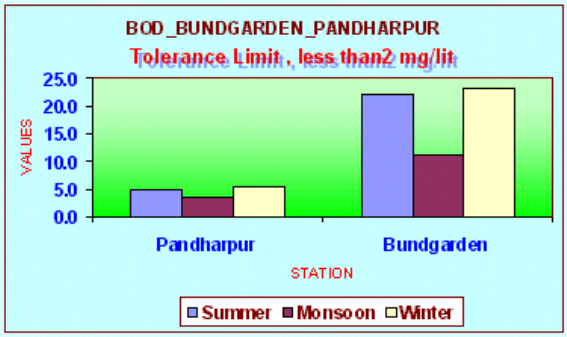

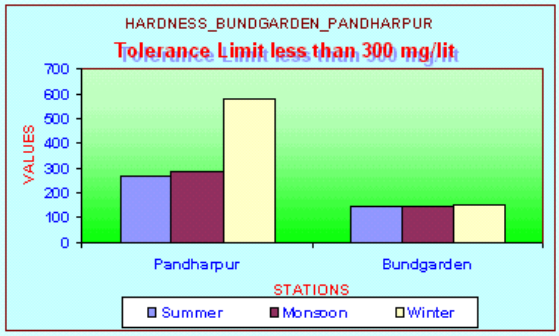

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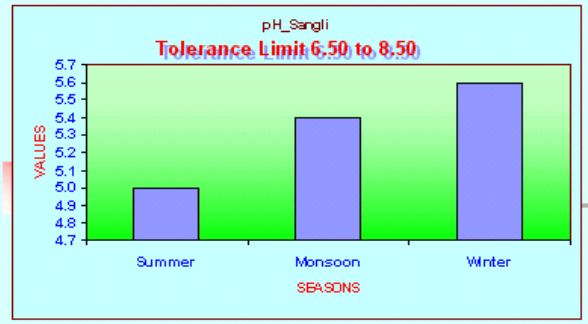

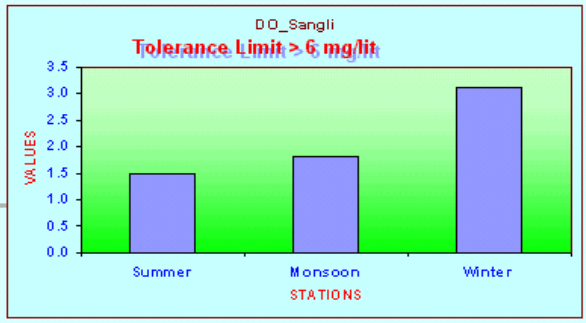

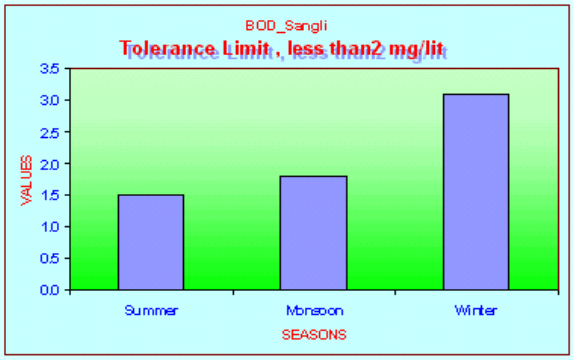

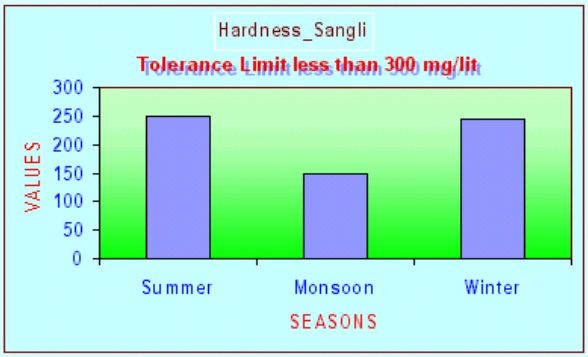

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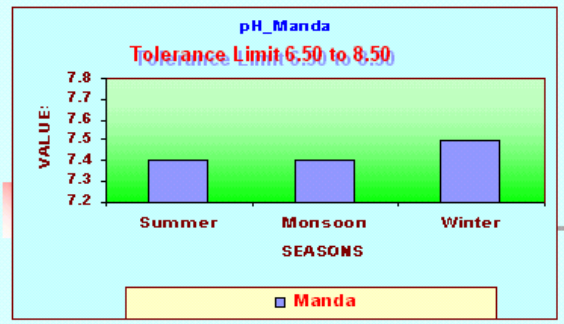
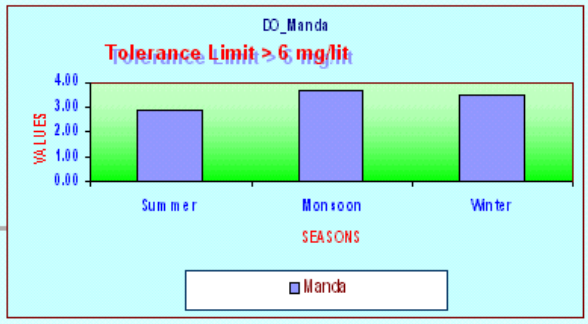
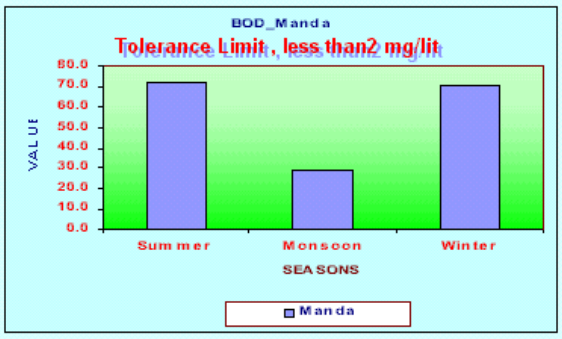
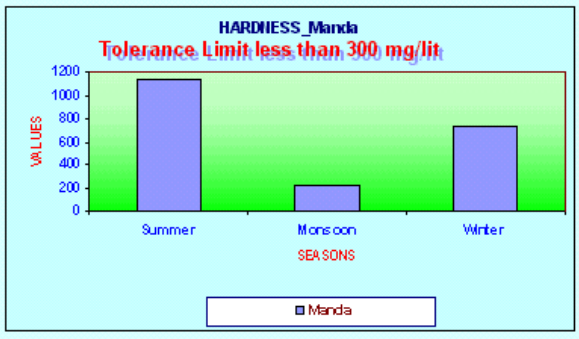
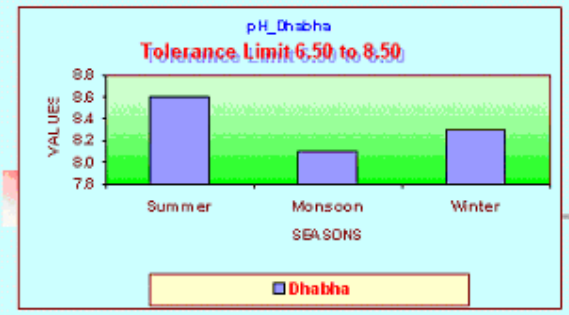


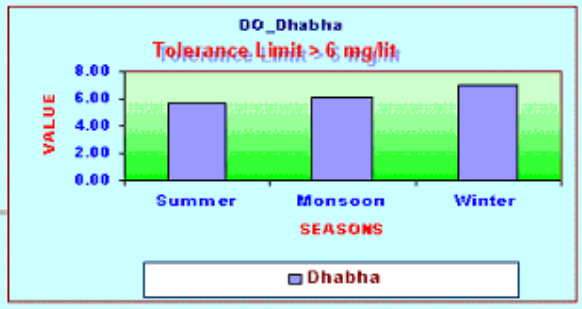


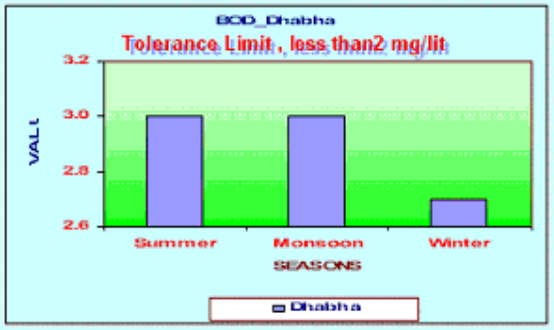


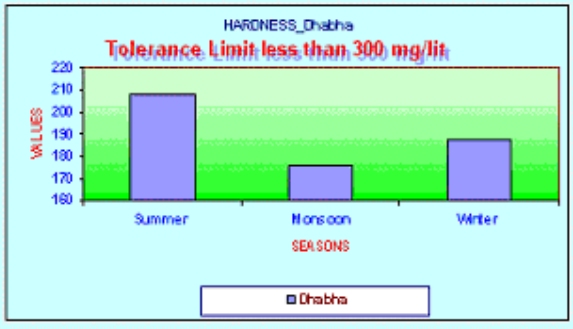


HOT SPOT:-MANDA

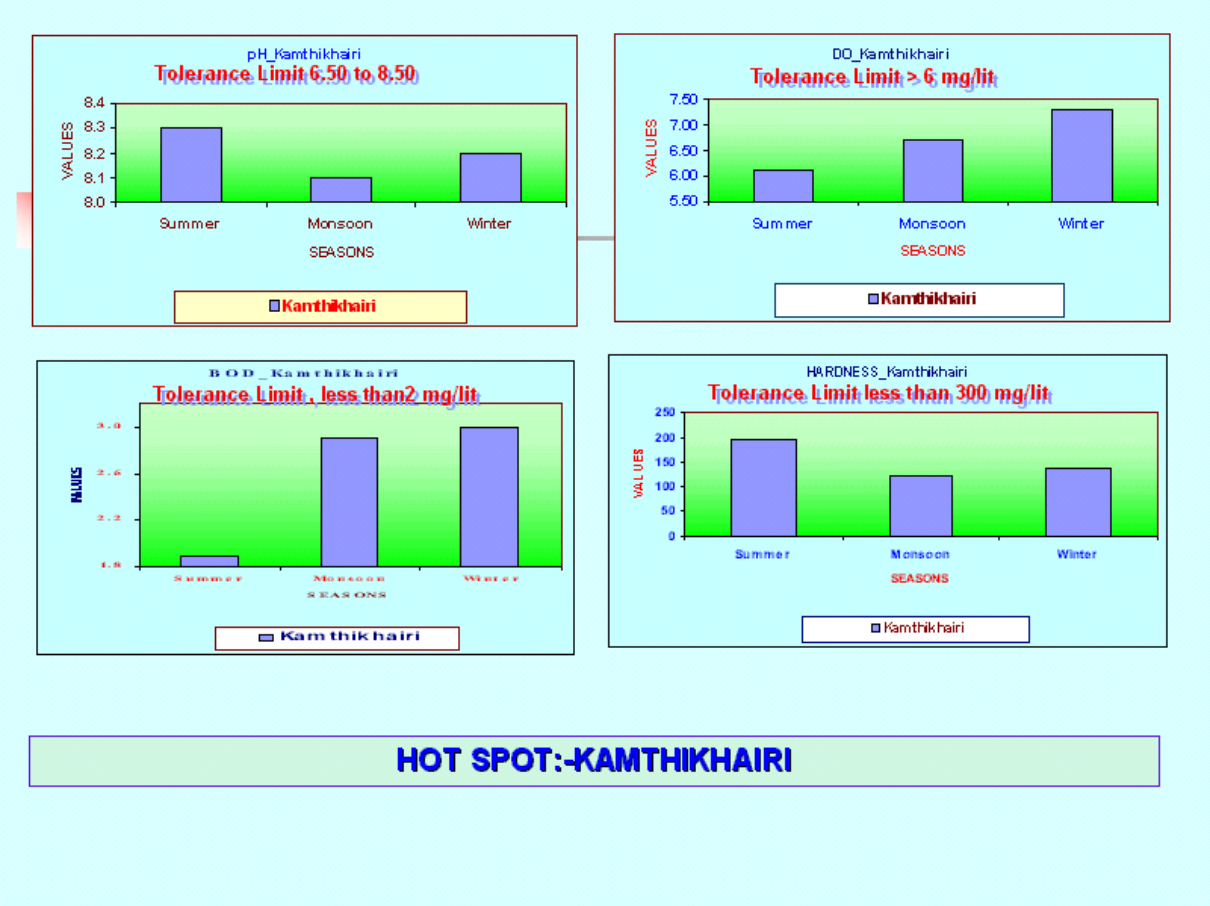








HOT SPOT:-DHABHA



7.2 Ground Water - Groundwater Surveys & Development Agency:

The following parameters are found to be maximum affected at the following locations:

pH: village Ajnale- taluka Sangola- dist Solapur- 10.2
village Yellur – taluka Walva – dist Sangli – 10.2
village Palaspur – taluka Himayatnagar- dist Nanded- 10.2

TDS: village Hirapur- taluka Georai – dist Beed – 6528 mg/L

Hardness: village Pujarwadi – taluka Atpadi – dist Sangli – 2720 mg/L

Alkalinity: village Pangaon- taluka Barshi – dist Solapur – 1000mg/L

Calcium: village Pujarwadi – taluka Atpadi- dist Sangli -944 mg/L

Sodium: village Shinganapur – taluka Daryapur – dist Amravati - 1530 mg/L

Iron: village Sonawade – taluka Kudal – dist Sindhudurga - 6.1 mg/L

Chloride: village Shinganapur – taluka Daryapur – dist Amravati - 2673 mg/L

Sulphate: village Kalkhed - taluka Shegaon - dist Buldhana - 1848 mg/L

Nitrate: village Muthad - taluka Bhokardan – dist Jalna - 239 mg/L

Fluoride: village Mop - taluka Risod –dist Washim - 6.0 mg/L

1. pH :

It is observed that the groundwater quality in the state is of alkaline nature. The maximum pH value observed is 10.2 for the following sources:

Nanded	Himayatnagar	Palaspur	Sangli
Naned	Kinwat	Apporopeth	Walwa
Solapur	Sangola	Ajnale	Yellur
Solapur	Sangola	Hangirge	

Comparison with BIS standard shows that total 137 sources have pH value more than 8.5, which are unacceptable for drinking purpose.

2. TDS:

An examination of TDS data shows that the highest value observed is 6528 mg/L at village Hirapur, taluka Gewara from Beed district, Total 61 sources have shown TDS value more than permissible limit that is 2000 mg/L.

3. Hardness:

The well water at village Pujarwadi, taluka Atpadi from Sangali district is having hardness value 2720 mg/L which is 2.5 times more than prescribed limit. In the Maharashtra state, 203 well waters have shown hardness value more than 600 mg/L. Pune and Aurangabad region is having more hardness problem as compared to other regions.

4. Alkalinity:

The maximum value of alkalinity observed is 1000 mg/L from village Pangaon, taluka Barshi from Solapur district. Total 21 well waters have exceeded the permissible limit of alkalinity and unsuitable for drinking purposes.

5. Calcium:

The well water at Pujarwadi village, Atpadi taluka, Sangli district is having Calcium value 944 mg/L. Total 56 well waters have exceeded the potable limit that is 200 mg/L.

6. Sodium:

The highest concentration of sodium observed is 1530 mg/L at village Shinganapur, taluka Daryapur from Amravati district which is 7.6 times more than the WHO guideline value. In the State 119 well waters have shown sodium concentration more than 200 mg/L. Higher concentration of sodium is observed in Amrawati region in the saline tract of Tapi-Purna alluvium.

7. Iron:

The maximum iron concentration observed is 6.1 mg/L at Sonawade village, taluka Kudal from Sindhudurga district. In the State 54 well waters have iron concentration more than 1.0 mg/l

8. Chloride:

Highest concentration of chloride is 2673 mg/L from Shinganapur village, Daryapur taluka, and Amravati district. Total 13 well waters have exceeded the maximum permissible value of chloride that is 1000 mg/L.

9. Sulphate:

The highest sulphate concentration observed is 1848 mg/L at Kalkhed village, taluka Shegaon from Buldhana district and is 4.6 times more than the prescribed BIS limit. Total 30 well waters have sulphate cocentration more than 400 mg/L.

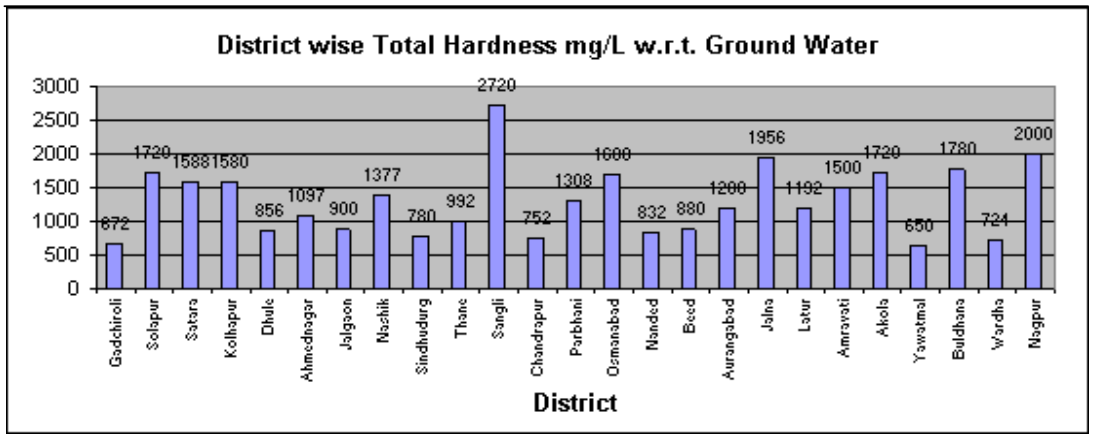
10. Nitrate:

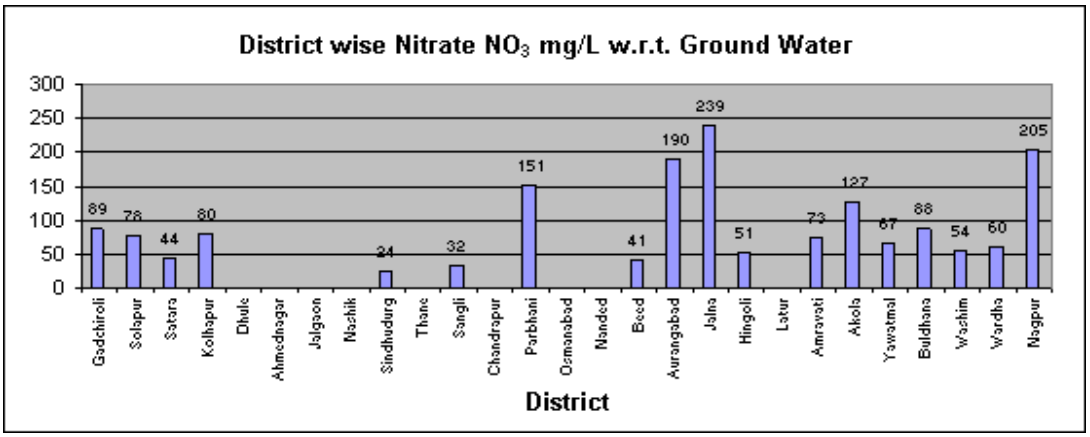
The maximum value of Nitrate observed is 239 mg/L at Muthad village, taluka Bhokardan from Jalna district and is 9 times more than the BIS permissible limit. It is also observed that 319 well waters have exceeded the BIS permissible limit.

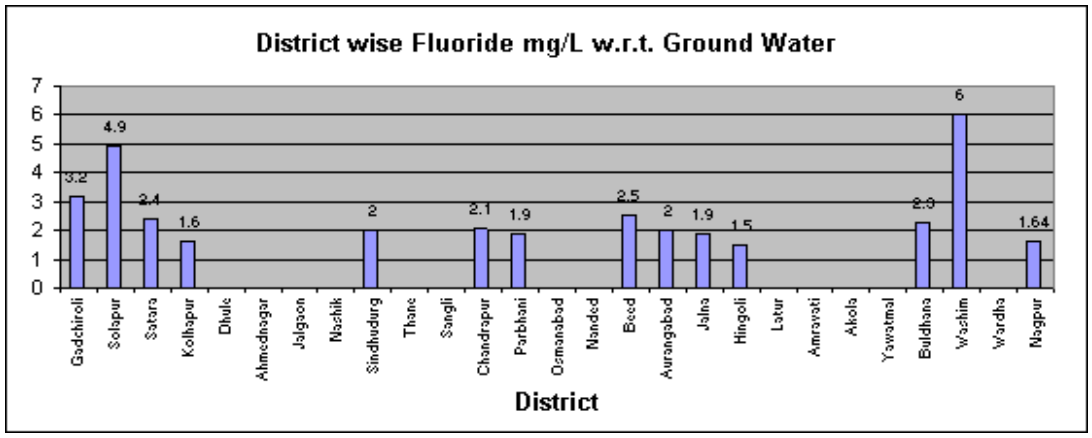
11. Fluoride:

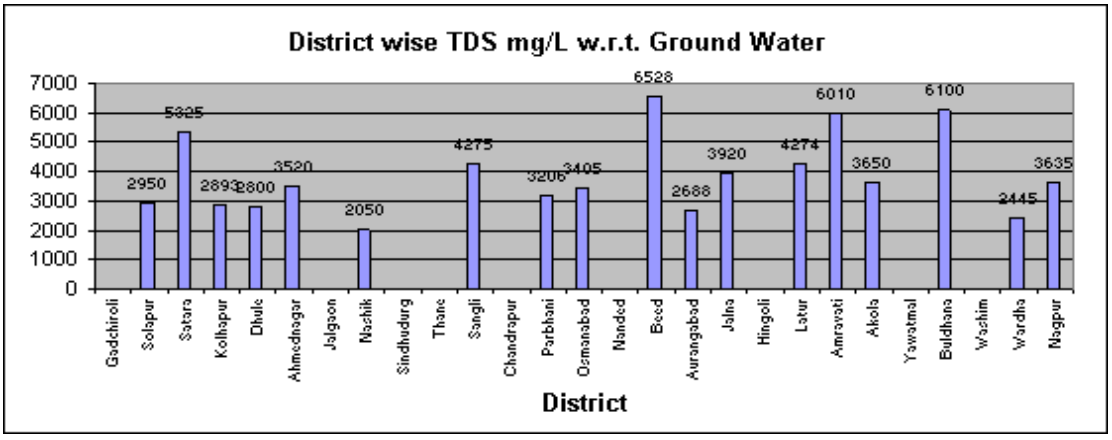
The highest value of fluoride observed is 6.0 mg/l from Mop village, Risod taluka, and Washim district. Total 56 well waters have fluoride concentration more than 1.5 mg/l; hence these sources are unacceptable for the community for drinking purposes.

Water Quality Monitored By GSDA








District wise TDS mg/L w.r.t. Ground Water
7000
6000
5000
4000
3000
2000
1000
0
2950
5325
2893
2800
3520
2050
4275
3206
3405
6528
2688
3920
4274
6010
3650
6100
2445
3635
Gadchiroli
Solapur
Satara
Kolhapur
Dhule
Ahmednagar
Jalgaon
Nashik
Sindhudurg
Thane
Sangli
Chandrapur
Parbhani
Osmanabad
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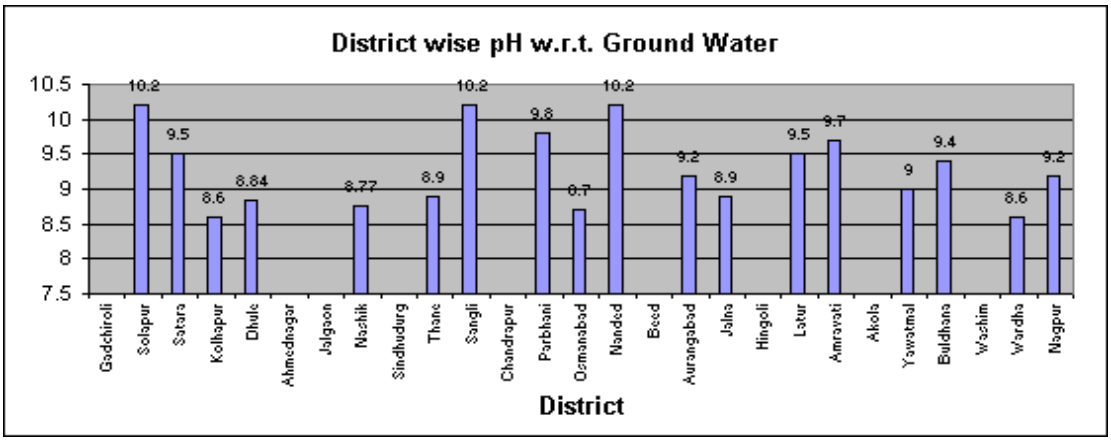
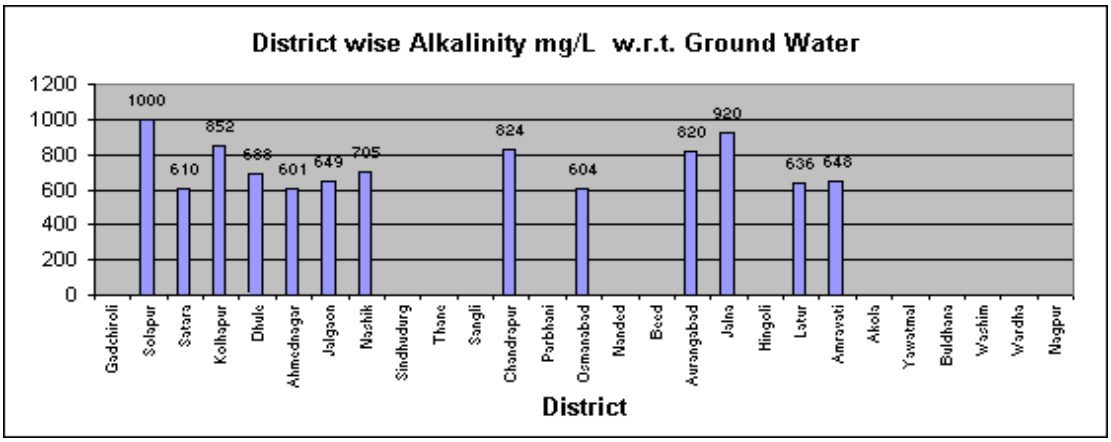
Nagpur
District


District wise pH w.r.t. Ground Water
10.5
10
9.5
9
8.5
8
7.5
10.2
9.5
8.6
8.84
8.77
8.9
10.2
9.8
8.7
10.2
9.2
8.9
9.5
9.7
9
9.4
8.6
9.2
Gadchiroli
Solapur
Satara
Kolhapur
Dhule
Ahmednagar
Jalgaon
Nashik
Sindhudurg
Thane
Sangli
Chandrapur
Parbhani
Osmanabad
Nanded
Beed
Aurangabad
Jalna
Hingoli
Latur
Amravati
Akola
Yavatmal
Buldhana
Washim
Wardha
Nagpur
District


District wise Alkalinity mg/L w.r.t. Ground Water
1200
1000
800
600
400
200
0
1000
610
852
688
601
649
705
824
604
820
920
636
648
Gadchiroli
Solapur
Satara
Kolhapur
Dhule
Ahmednagar
Jalgaon
Nashik
Sindhudurg
Thane
Sangli
Chandrapur
Parbhani
Osmanabad
Nanded
Beed
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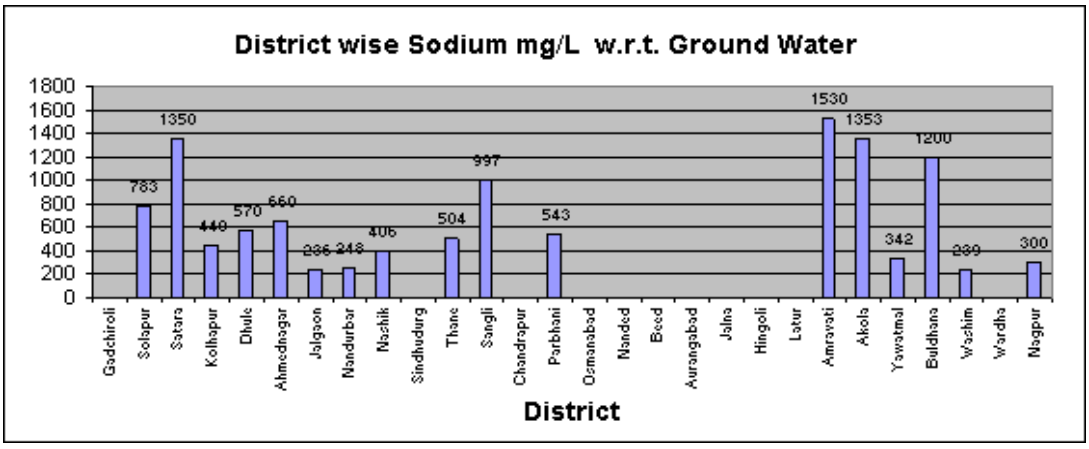
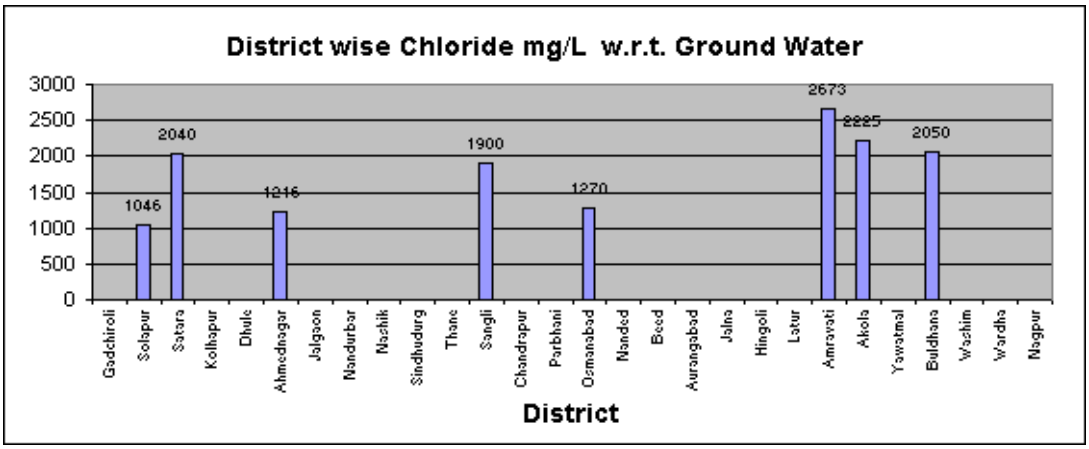
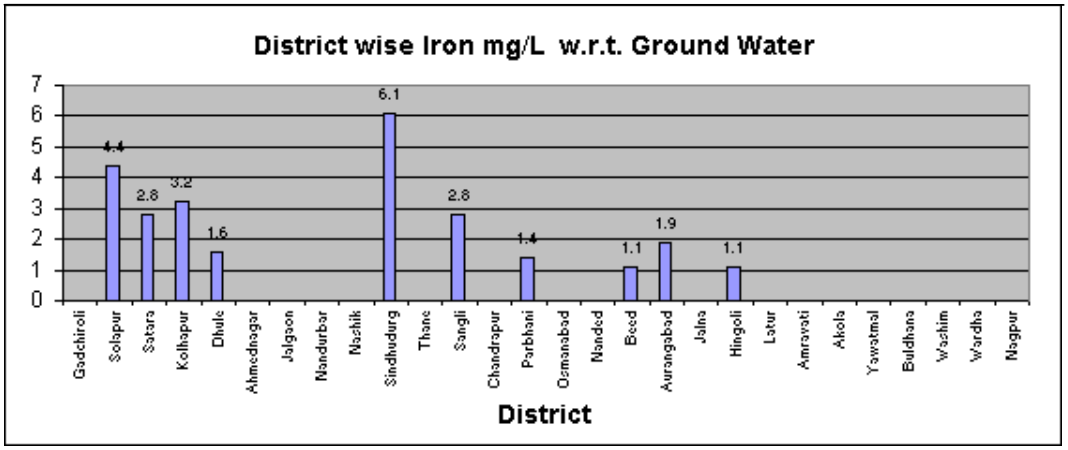
Jalna
Hingoli
Latur
Amravati
Akola
Yavatmal
Buldhana
Washim
Wardha
Nagpur
District


District wise Sodium mg/L w.r.t. Ground Water
1800
1600
1400
1200
1000
800
600
400
200
0
783
1350
449
570
660
236
248
406
504
997
543
1530
1353
1200
342
239
300
Gadchiroli
Solapur
Satara
Kolhapur
Dhule
Ahmednagar
Jalgaon
Nandurbar
Nashik
Sindhudurg
Thane
Sangli
Chandrapur
Parbhani
Osmanabad
Nanded
Beed
Aurangabad
Jalna
Hingoli
Latur
Amravati
Akola
Yawatmal
Buldhana
Washim
Wardha
Nagpur
District


District wise Chloride mg/L w.r.t. Ground Water
3000
2500
2000
1500
1000
500
0
1046
2040
1246
1900
1270
2673
2225
2050
Gadchiroli
Solapur
Satara
Kolhapur
Dhule
Ahmednagar
Jalgaon
Nandurbar
Nashik
Sindhudurg
Thane
Sangli
Chandrapur
Parbhani
Osmanabad
Nanded
Beed
Aurangabad
Jalna
Hingoli
Latur
Amravati
Akola
Yawatmal
Buldhana
Washim
Wardha
Nagpur
District


District wise Iron mg/L w.r.t. Ground Water
7
6
5
4
3
2
1
0
4.4
2.8
3.2
1.6
6.1
2.8
1.4
1.1
1.9
1.1
Gadchiroli
Solapur
Satara
Kolhapur
Dhule
Ahmednagar
Jalgaon
Nandurbar
Nashik
Sindhudurg
Thane
Sangli
Chandrapur
Parbhani
Osmanabad
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Beed
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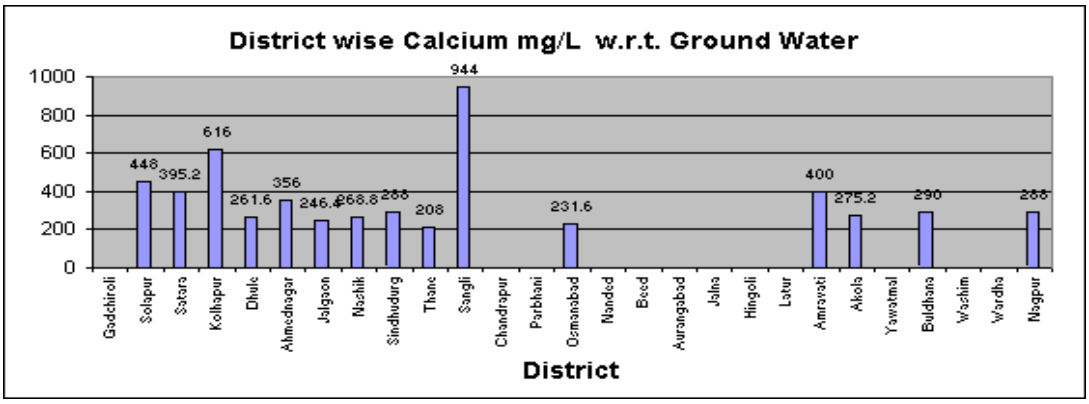
Akola
Yawatmal
Buldhana
Washim
Wardha
Nagpur
District


District wise Calcium mg/L w.r.t. Ground Water
1000
800
600
400
200
0
448
395.2
616
261.6
356
246.4
268.8
288
208
944
231.6
400
275.2
290
288
Gadchiroli
Solapur
Satara
Kolhapur
Dhule
Ahmednagar
Jalgaon
Nashik
Sindhudurg
Thane
Sangli
Chandrapur
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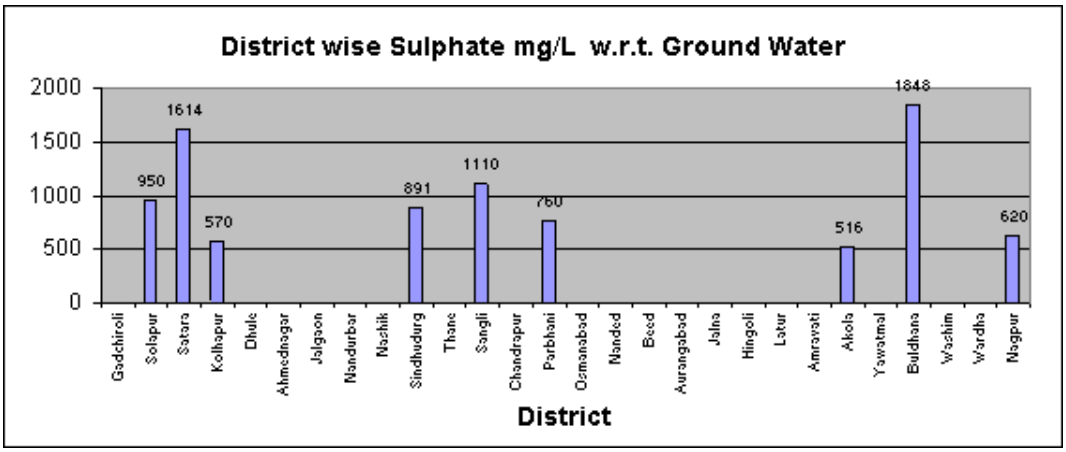
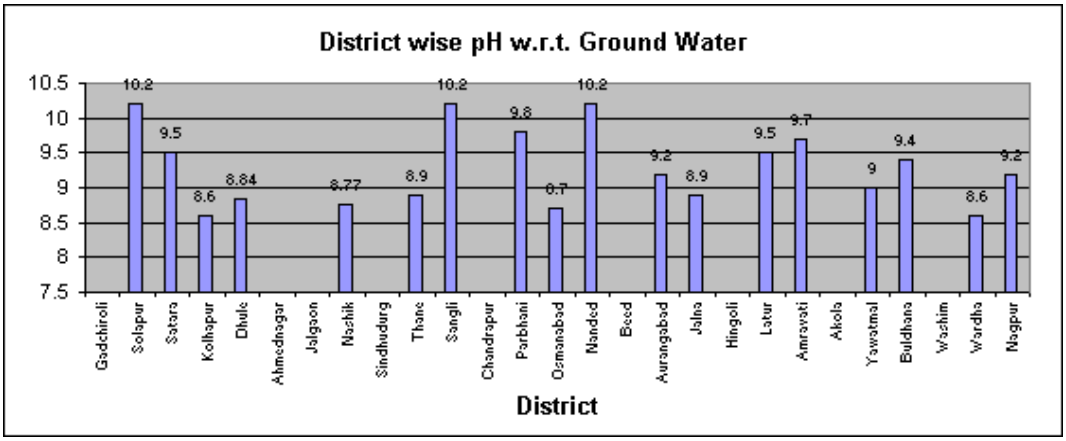
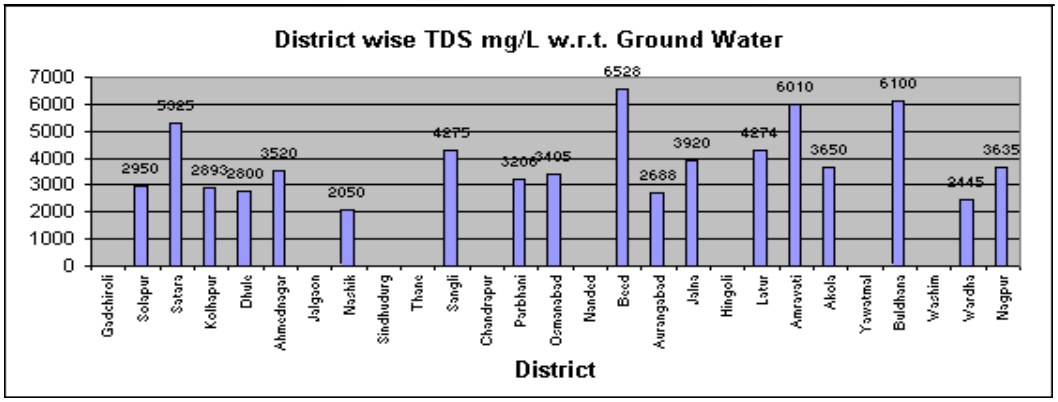
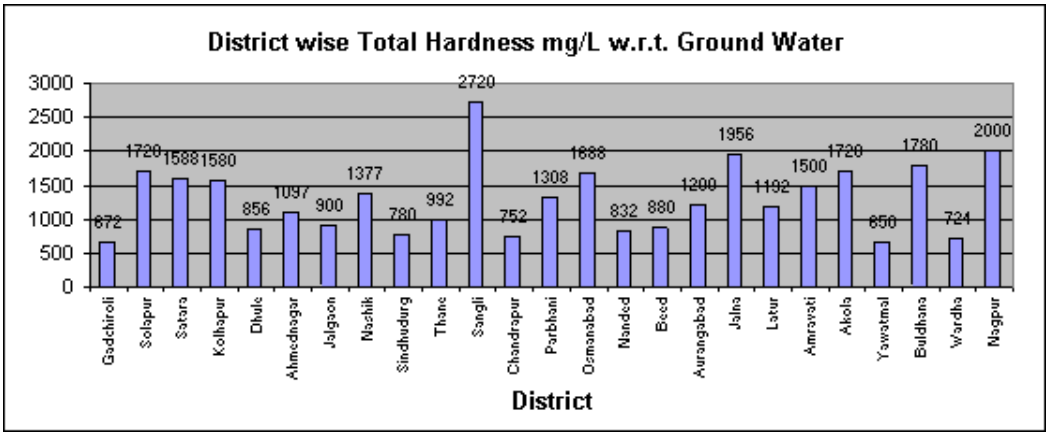
Buldhana
Washim
Wardha
Nagpur
District

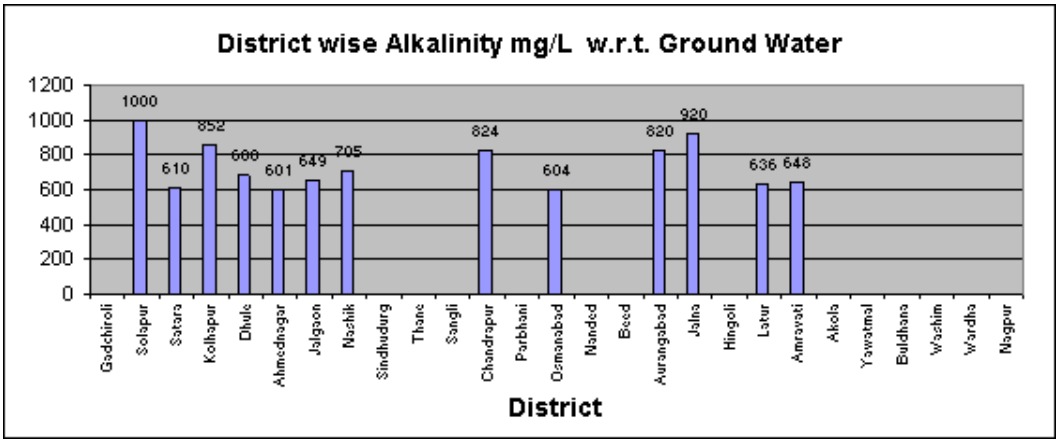

District wise Sulphate mg/L w.r.t. Ground Water
2000
1500
1000
500
0
950
1614
570
891
1110
760
516
1848
620
Gadchiroli
Solapur
Satara
Kolhapur
Dhule
Ahmednagar
Jalgaon
Nandurbar
Nashik
Sindhudurg
Thane
Sangli
Chandrapur
Parbhani
Osmanabad
Nanded
Beed
Aurangabad
Jalna
Hingoli
Latur
Amravati
Akola
Yawatmal
Buldhana
Washim
Wardha
Nagpur
District

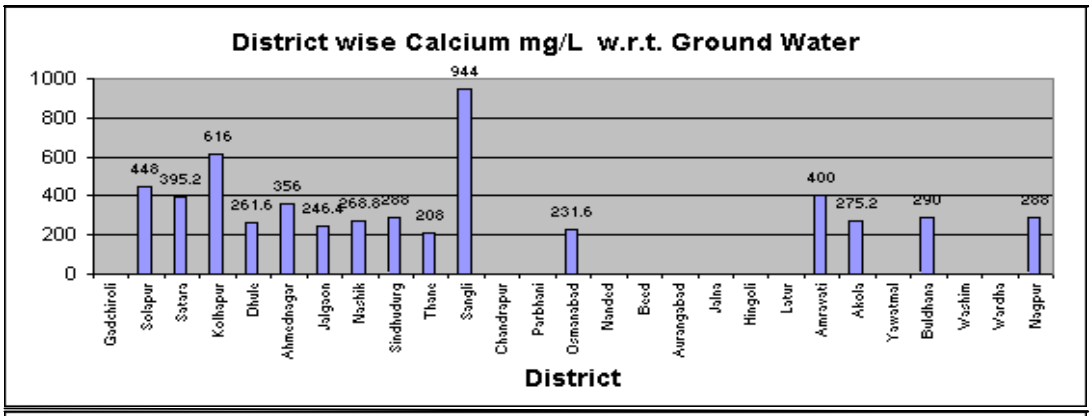

District wise pH w.r.t. Ground Water
10.5
10
9.5
9
8.5
8
7.5
10.2
9.5
8.6
8.84
8.77
8.9
10.2
9.8
8.7
10.2
9.2
8.9
9.5
9.7
9
9.4
8.6
9.2
Gadchiroli
Solapur
Satara
Kolhapur
Dhule
Ahmednagar
Jalgaon
Nashik
Sindhudurg
Thane
Sangli
Chandrapur
Parbhani
Osmanabad
Nanded
Beed
Aurangabad
Jalna
Hingoli
Latur
Amravati
Akola
Yawatmal
Buldhana
Washim
Wardha
Nagpur
District

Water Quality Monitored By GSDA








District wise Calcium mg/L w.r.t. Ground Water
1000
800
600
400
200
0
448
395.2
616
261.6
356
246.4
268.8
288
208
944
231.6
400
275.2
290
288
Gadchiroli
Solapur
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Nashik
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Thane
Sangli
Chandrapur
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Nanded
Beed
Aurangabad
Jalna
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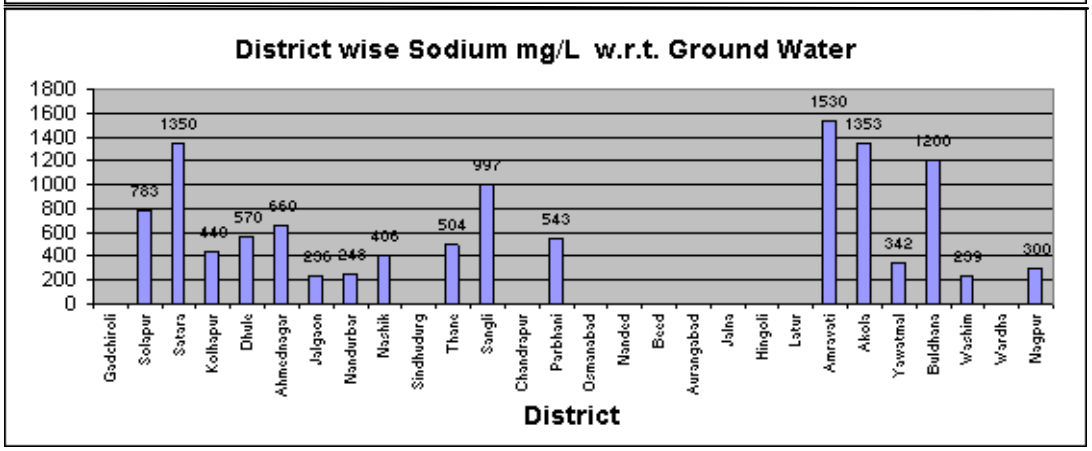
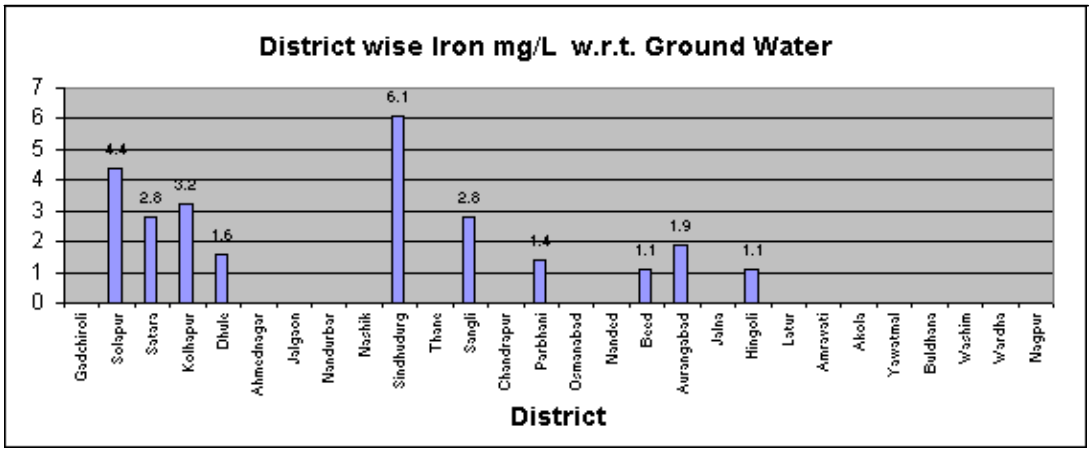
Latur
Amravati
Akola
Yawatmal
Buldhana
Washim
Wardha
Nagpur
District


District wise Sodium mg/L w.r.t. Ground Water
1800
1600
1400
1200
1000
800
600
400
200
0
783
1350
449
570
660
236
248
406
504
997
543
1530
1353
1200
342
299
300
Gadchiroli
Solapur
Satara
Kolhapur
Dhule
Ahmednagar
Jalgaon
Nandurbar
Nashik
Sindhudurg
Thane
Sangli
Chandrapur
Parbhani
Osmanabad
Nanded
Beed
Aurangabad
Jalna
Hingoli
Latur
Amravati
Akola
Yawatmal
Buldhana
Washim
Wardha
Nagpur
District


District wise Iron mg/L w.r.t. Ground Water
7
6
5
4
3
2
1
0
4.4
2.8
3.2
1.6
6.1
2.8
1.4
1.1
1.9
1.1
Gadchiroli
Solapur
Satara
Kolhapur
Dhule
Ahmednagar
Jalgaon
Nandurbar
Nashik
Sindhudurg
Thane
Sangli
Chandrapur
Parbhani
Osmanabad
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Buldhana
Washim
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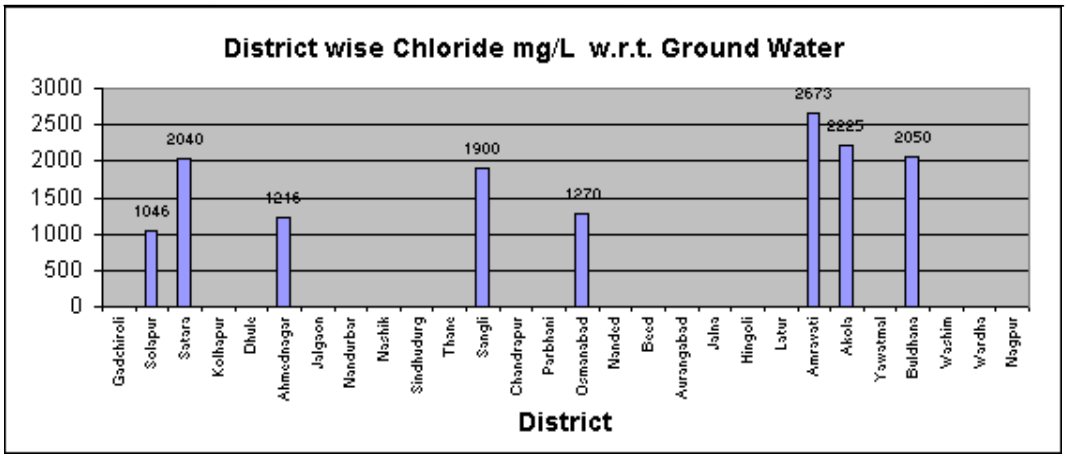
Nagpur
District


District wise Chloride mg/L w.r.t. Ground Water
3000
2500
2000
1500
1000
500
0
1046
2040
1216
1900
1270
2673
2225
2050
Gadchiroli
Solapur
Satara
Kolhapur
Dhule
Ahmednagar
Jalgaon
Nandurbar
Nashik
Sindhudurg
Thane
Sangli
Chandrapur
Parbhani
Osmanabad
Nanded
Beed
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Jalna
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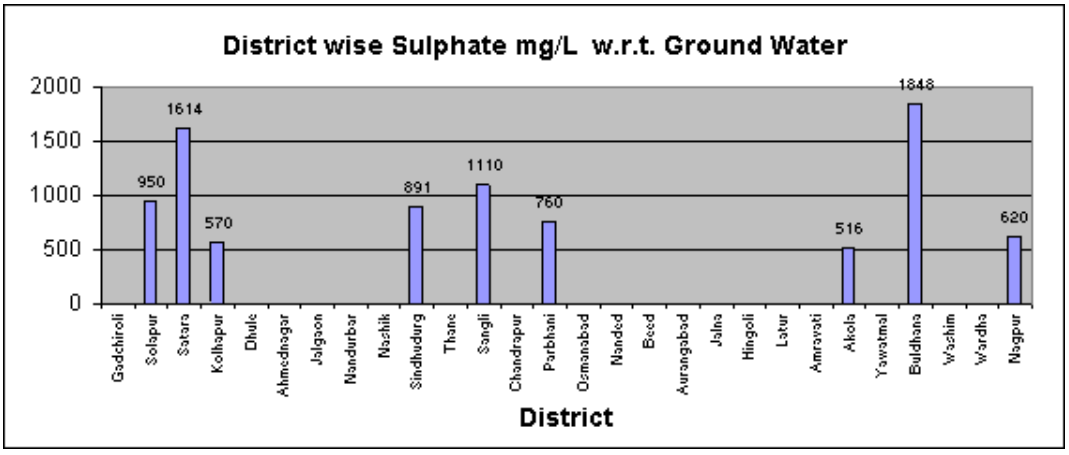
Latur
Amravati
Akola
Yawatmal
Buldhana
Washim
Wardha
Nagpur
District


District wise Sulphate mg/L w.r.t. Ground Water
2000
1500
1000
500
0
950
1614
570
891
1110
760
516
1848
620
Gadchiroli
Solapur
Satara
Kolhapur
Dhule
Ahmednagar
Jalgaon
Nandurbar
Nashik
Sindhudurg
Thane
Sangli
Chandrapur
Parbhani
Osmanabad
Nanded
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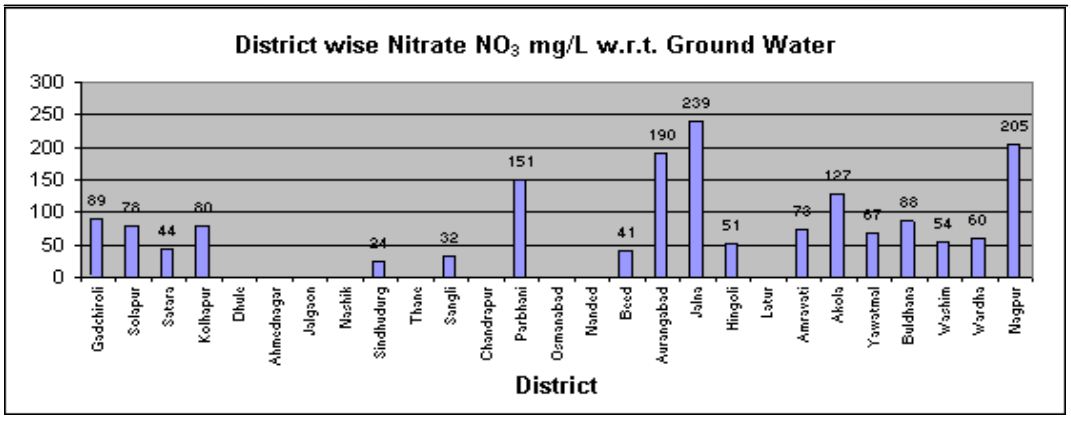
Aurangabad
Jalna
Hingoli
Latur
Amravati
Akola
Yawatmal
Buldhana
Washim
Wardha
Nagpur
District


District wise Nitrate NO3 mg/L w.r.t. Ground Water
300
250
200
150
100
50
0
89
78
44
80
24
32
151
41
190
239
51
73
127
67
88
54
60
205
Gadchiroli
Solapur
Satara
Kolhapur
Dhule
Ahmednagar
Jalgaon
Nashik
Sindhudurg
Thane
Sangli
Chandrapur
Parbhani
Osmanabad
Nanded
Beed
Aurangabad
Jalna
Hingoli
Latur
Amravati
Akola
Yawatmal
Buldhana
Washim
Wardha
Nagpur
District

7.3 Maharashtra Pollution Control Board:

The following parameters are seen to be exceeding the limits at the following locations:

pH: village Ajanad: Tapi River – 8.6
BOD: Mahim Creek – Mahim Bay -22.9 mg/L
DO: Mahim Creek – Mahim Bay – 3.0 mg/L
Total Coliform – Nanded – Godavari River - 2878

1. pH

The maximum average pH has been noted as 8.6 at village Ajanad on Tapi River.

2. Biochemical Oxygen Demand (BOD)

The maximum average BOD has been noted as 22.9 mg/L at Mahim Creek on Mahim Bay followed by 21.9 mg/L at D/s of Pandharpur on Chandrabhaga River.

3. Dissolved Oxygen (DO)

The least average DO has been noted as 3.0 mg/l at Mahim Creek on Mahim Bay followed by 3.2 mg/L at D/s of Bundgarden on Bhima River.

4. Total Coliform

The maximum average number of Total Coliform has been noted as 2878 at Nanded on Godavari River.

7.4 Central Ground Water Board:

The following parameters are seen to be exceeding the limits at the following locations:

Electrical Conductivity: village Akola- dist Akola - 6200 µmhos/cm

TDS: village Manjur – dist Ahmednagar - 3920 mg/L

Total Hardness: village Shegaon – dist Buldhana - 2305 mg/L

Calcium: village Jafrabad – dist Jalna - 680 mg/L

Magnesium: village Sadawan Bk – dist Jalgaon - 333 mg/L

Sodium: village Bhatkulijain – dist Amravati - 1052 mg/L

Potassium: village Kukadgaon – dist Osmanabad - 323 mg/L

Chloride: village Dapoli – dist Raigad - 1911 mg/L

Sulphate: village Manjur – dist Ahmednagar - 1771 mg/L

Nitrate: village Sadawan Bk – dist Jalgaon - 899 mg/L

Fluoride: village Daodipar Khapa - dist Bhandara. - 4.2 mg/L

1. **Electrical Conductivity**
   The maximum Electrical Conductivity has been noted as 6200 µmhos/cm at village Akola from Akola district and Manjur from Ahmednagar district.

2. **Total Dissolved Solids**
   The maximum Total Dissolved Solids has been noted as 3920 mg/L at village \ Manjur from Ahmednagar district.

3. **Total Hardness**
   The maximum Total Hardness has been noted as 2305 mg/L at village Shegaon from Buldhana district.

4. **Calcium**
   The maximum Calcium has been noted as 680 mg/L at village Jafrabad from Jalna district.

5. **Magnesium**
   The maximum Magnesium has been noted as 333 mg/L at Sadawan Bk. from Jalgaon district.

6. **Sodium**
   The maximum Sodium has been noted as 1052 mg/L at Bhatkulijain from Amravati district.

7. **Potassium**
   The maximum Potassium has been noted as 323 mg/L at village Kukadgaon from Osmanabad district.

8. **Chloride**
   The maximum Chloride has been noted as 1911 mg/L at Dapoli from Raigad district.

9. **Sulphate**
   The maximum Sulphate has been noted as 1771 mg/L at Manjur from Ahmednagar district.

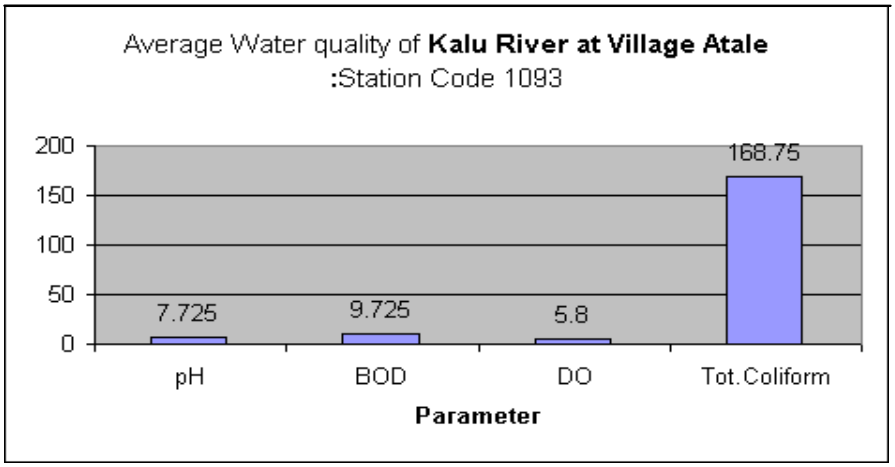
10. **Nitrate**
    The maximum Nitrate has been noted as 899 mg/L at Sadawan Bk from Jalgaon district.

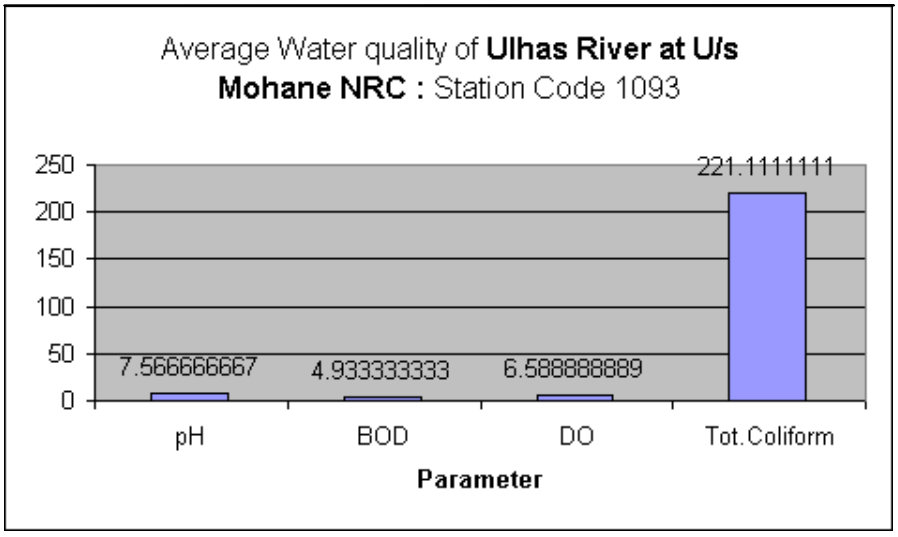
11. **Fluoride**
    The maximum Fluoride has been noted as 4.2 mg/L at Daodipar Khapa from Bhandara district.

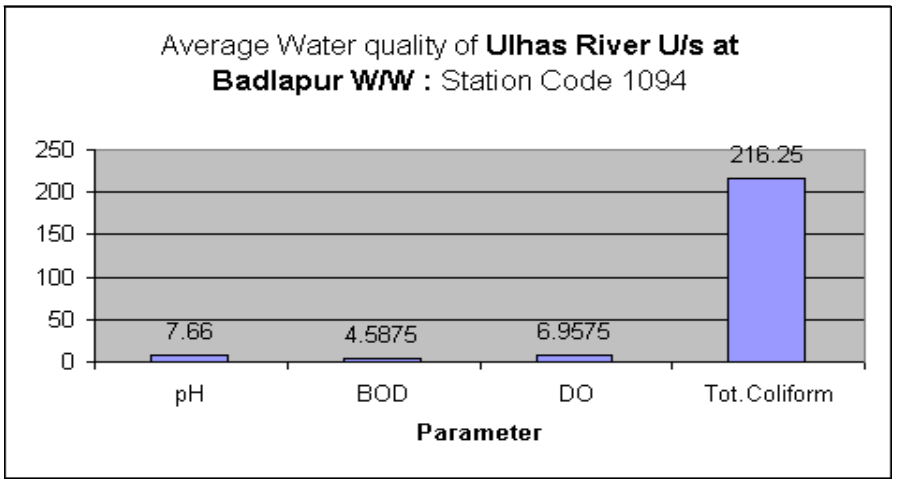
7.5 Central Water Commission:

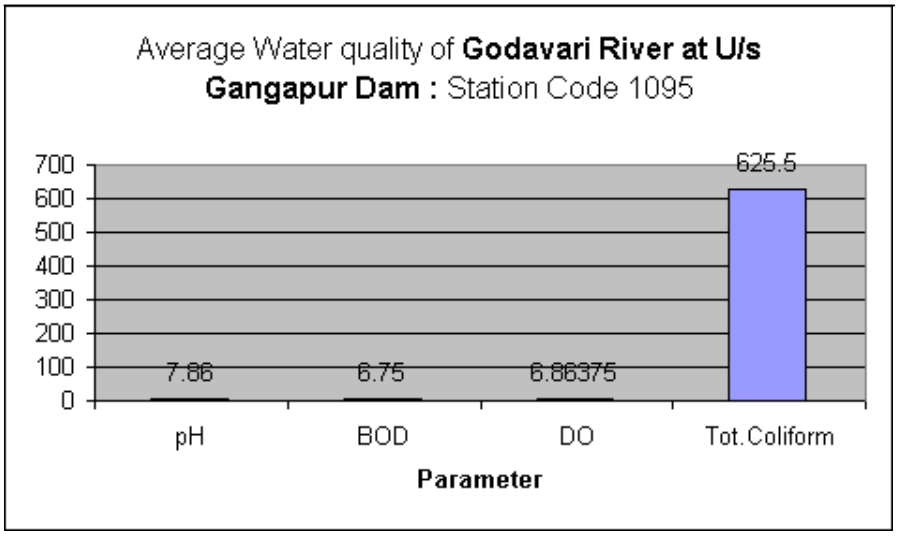
Since stations are few and data is inadequate, not considered for interpretation.

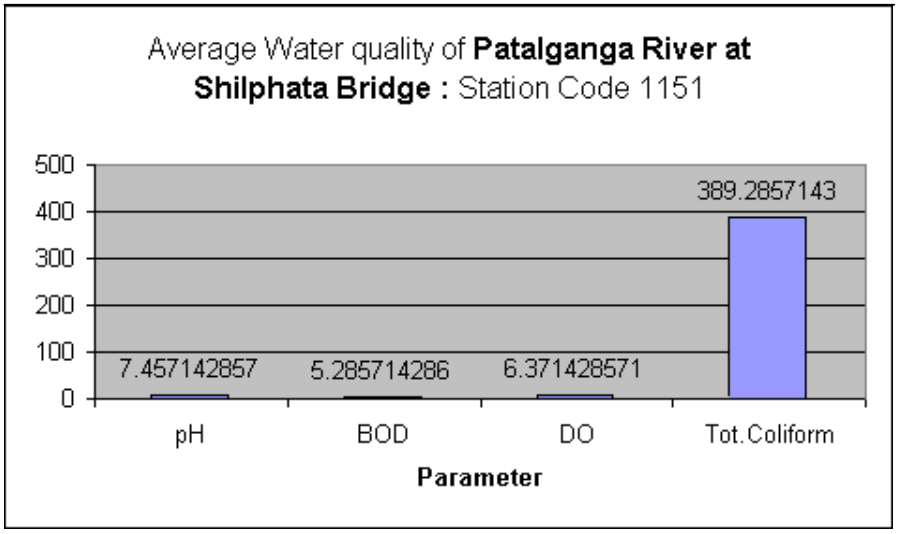
Water Quality data monitored by M.P.C.B. under MINARS Project during the period January-2005 - September - 2005

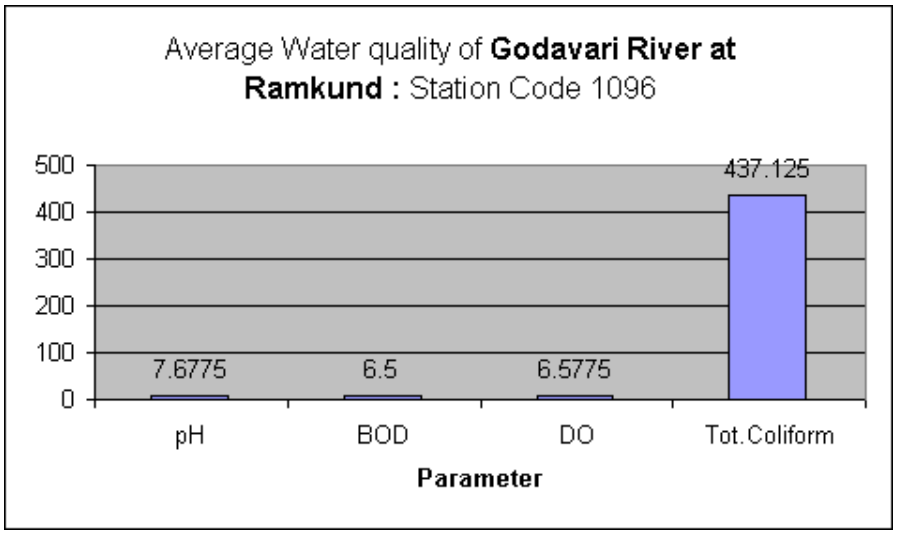


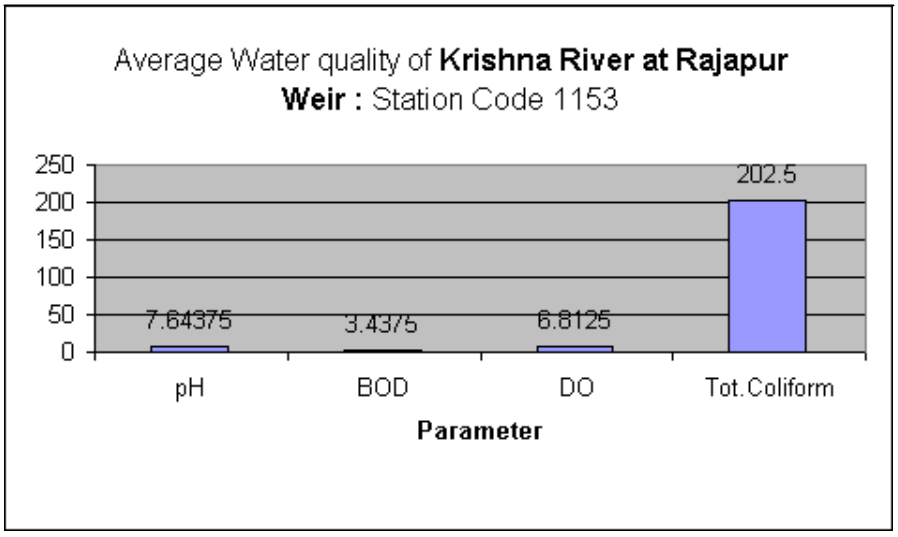


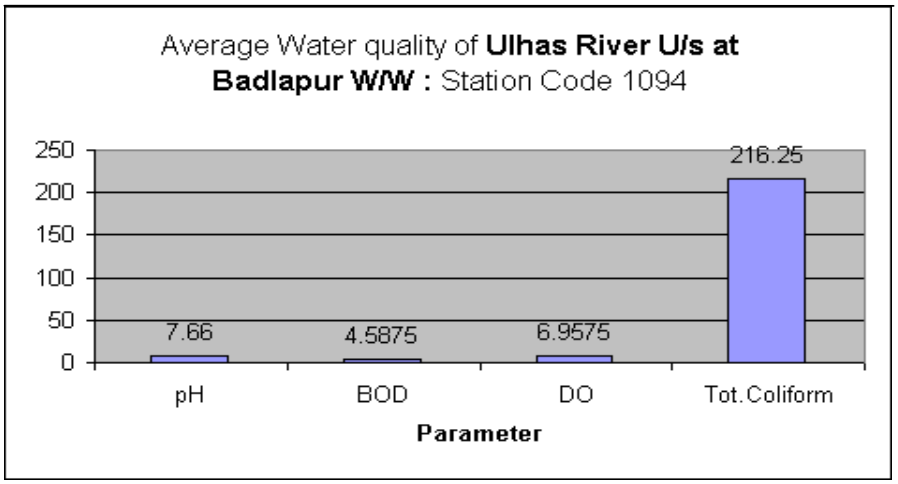


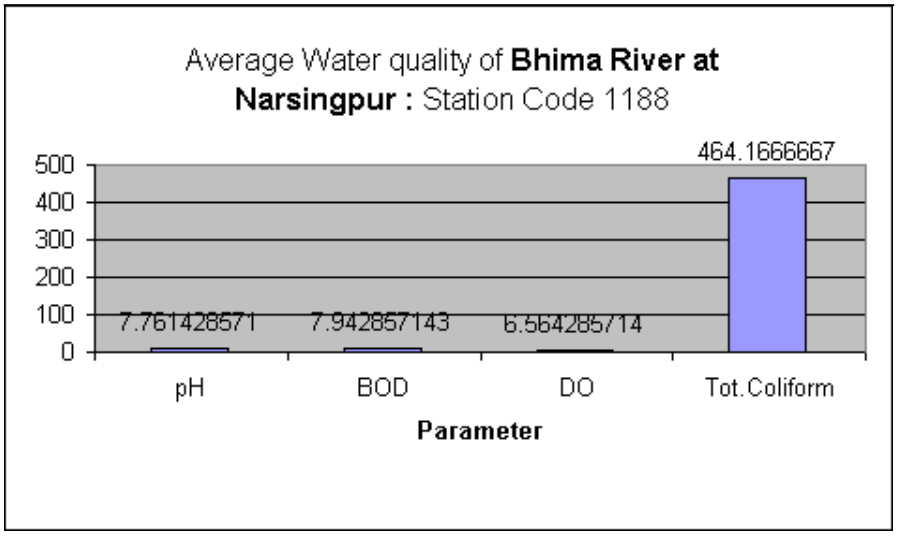

Average Water quality of **Godavari River at U/s Gangapur Dam :** Station Code 1095
700
600
500
400
300
200
100
0
7.86
6.75
6.86375
625.5
pH
BOD
DO
Tot.Coliform
Parameter

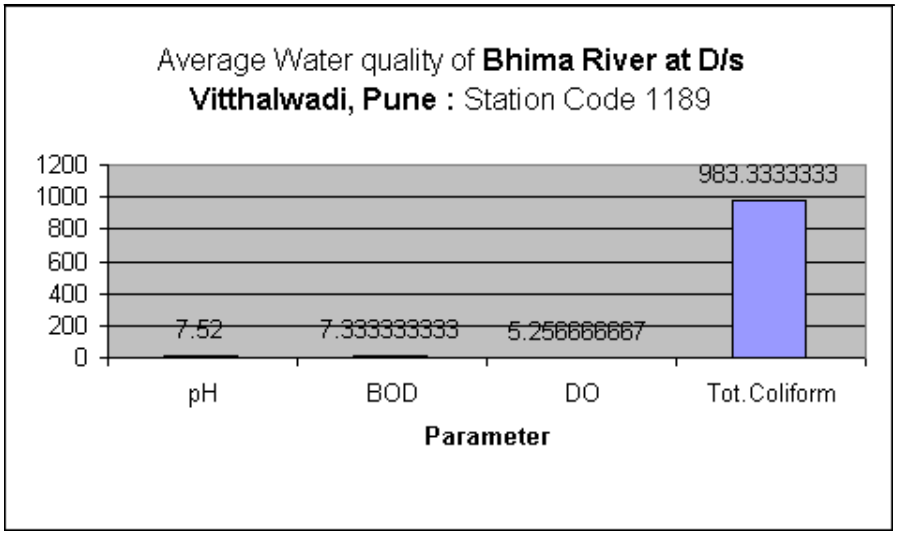

Average Water quality of **Patalganga River at Shilphata Bridge :** Station Code 1151
500
400
300
200
100
0
7.457142857
5.285714286
6.371428571
389.2857143
pH
BOD
DO
Tot.Coliform
Parameter

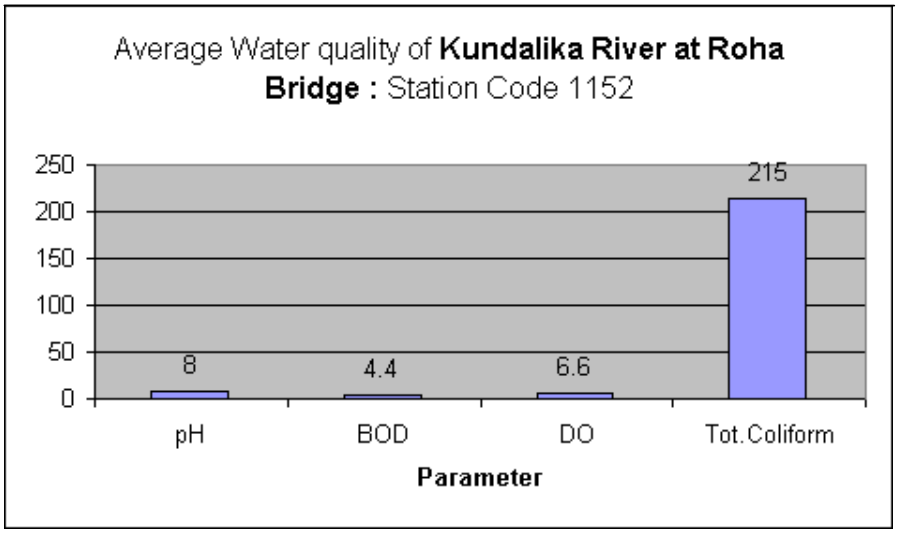

Average Water quality of **Godavari River at Ramkund :** Station Code 1096
500
400
300
200
100
0
7.6775
6.5
6.5775
437.125
pH
BOD
DO
Tot.Coliform
Parameter

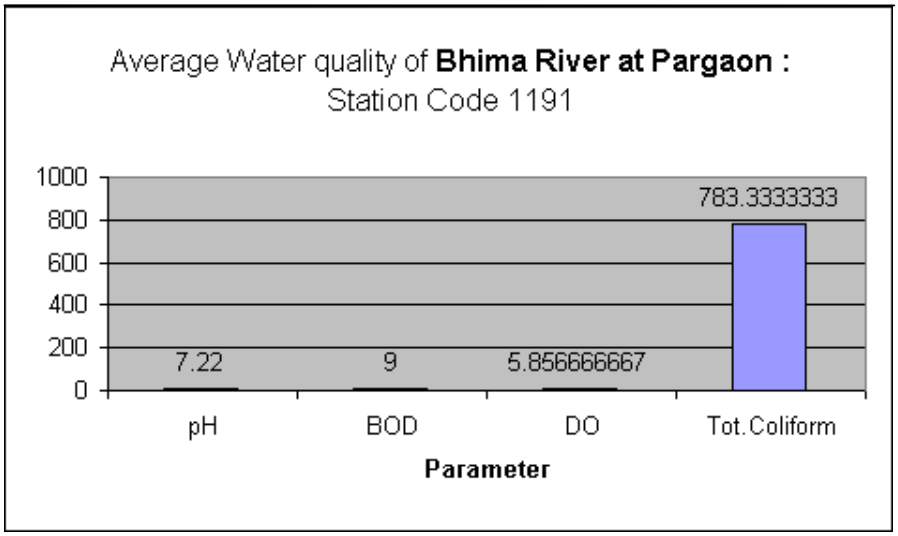

Average Water quality of **Krishna River at Rajapur Weir :** Station Code 1153
250
200
150
100
50
0
7.64375
3.4375
6.8125
202.5
pH
BOD
DO
Tot.Coliform
Parameter

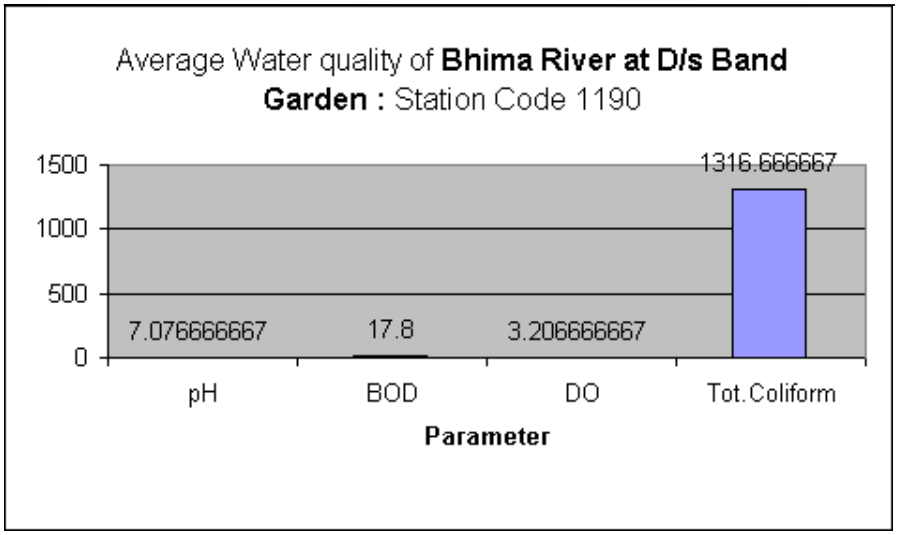

Average Water quality of **Ulhas River U/s at Badlapur W/W :** Station Code 1094
250
200
150
100
50
0
7.66
4.5875
6.9575
216.25
pH
BOD
DO
Tot.Coliform
Parameter

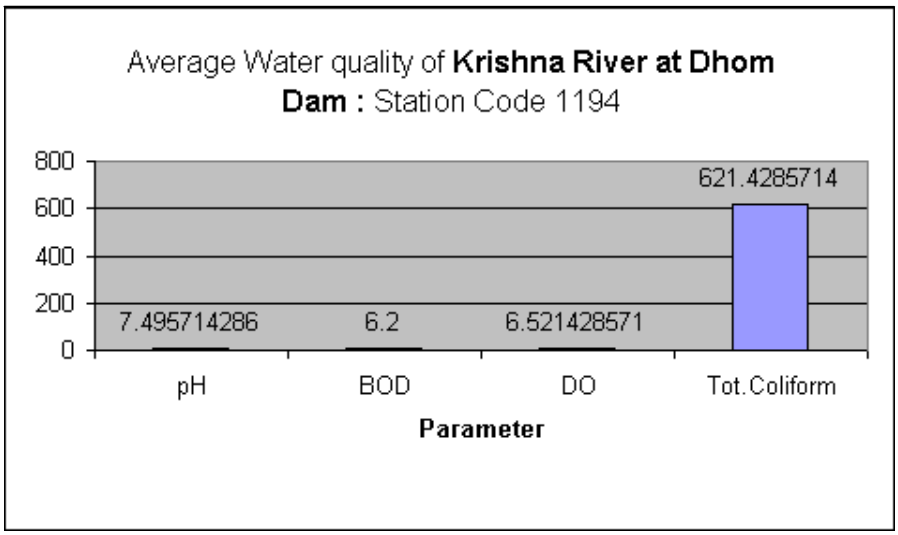

Average Water quality of **Bhima River at Narsingpur :** Station Code 1188
500
400
300
200
100
0
7.761428571
7.942857143
6.564285714
464.1666667
pH
BOD
DO
Tot.Coliform
Parameter

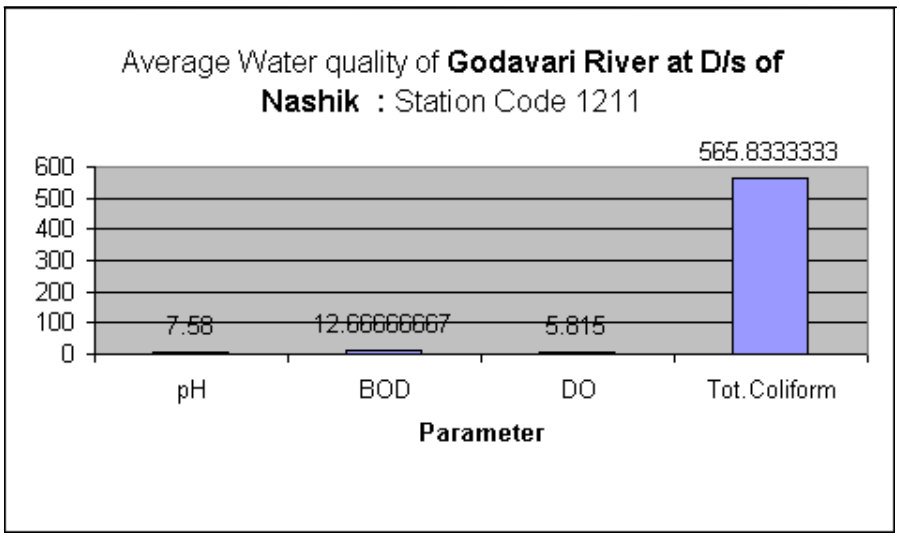

Average Water quality of **Bhima River at D/s Vitthalwadi, Pune :** Station Code 1189
1200
1000
800
600
400
200
0
983.3333333
7.52
7.333333333
5.256666667
pH
BOD
DO
Tot.Coliform
Parameter

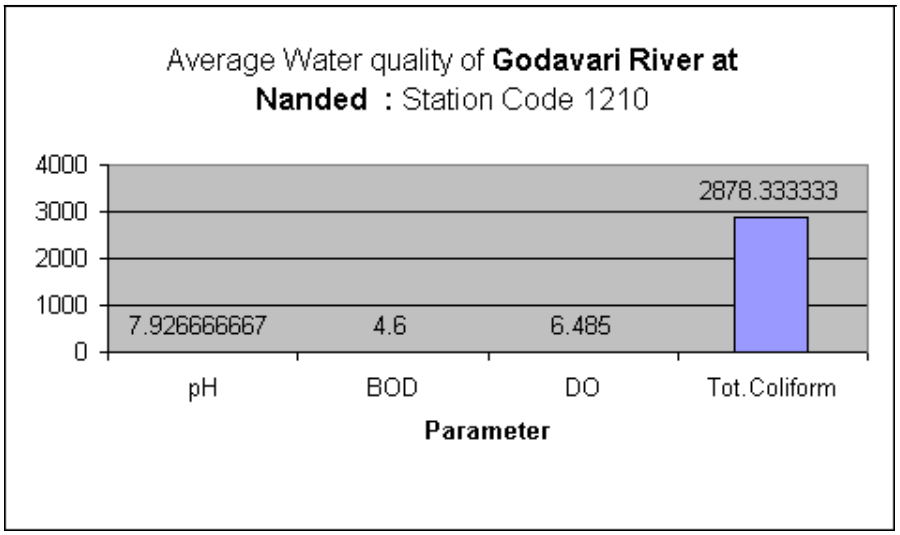

Average Water quality of **Kundalika River at Roha Bridge :** Station Code 1152
250
200
150
100
50
0
215
8
4.4
6.6
pH
BOD
DO
Tot.Coliform
Parameter

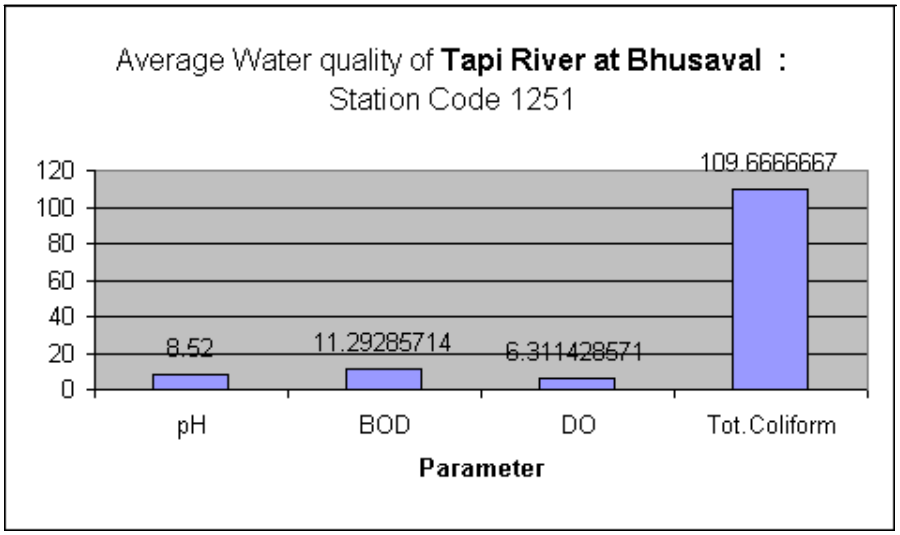

Average Water quality of **Bhima River at Pargaon :** Station Code 1191
1000
800
600
400
200
0
783.3333333
7.22
9
5.856666667
pH
BOD
DO
Tot.Coliform
Parameter

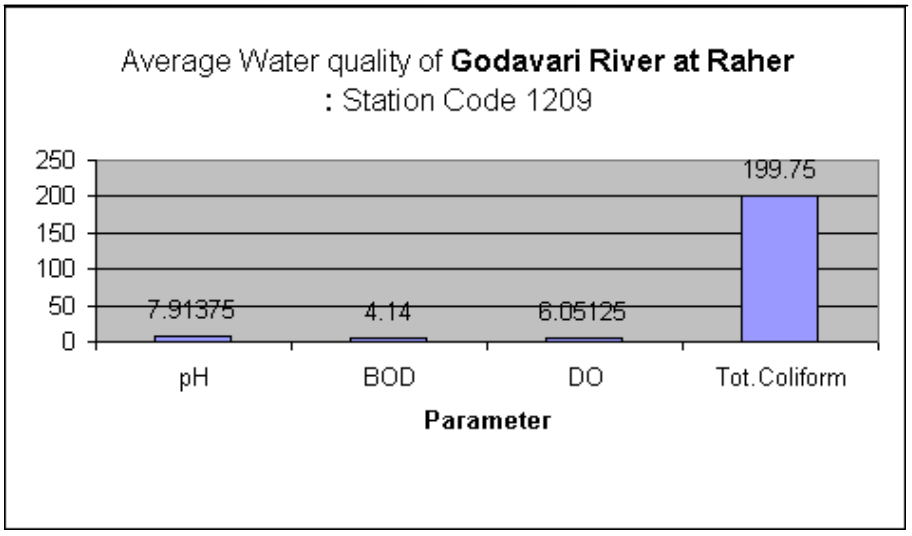

Average Water quality of **Bhima River at D/s Band Garden :** Station Code 1190
1500
1000
500
0
1316.666667
7.076666667
17.8
3.206666667
pH
BOD
DO
Tot.Coliform
Parameter

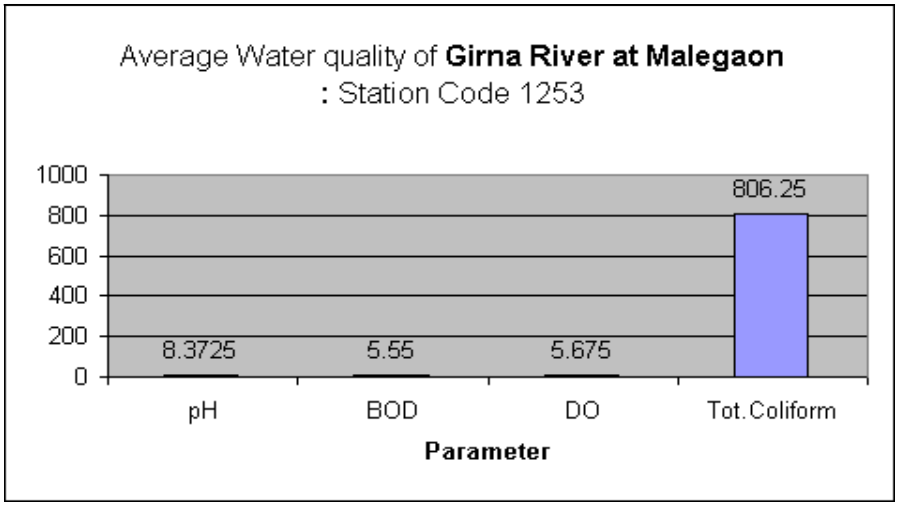

Average Water quality of **Krishna River at Dhom Dam :** Station Code 1194
800
600
400
200
0
621.4285714
7.495714286
6.2
6.521428571
pH
BOD
DO
Tot.Coliform
Parameter

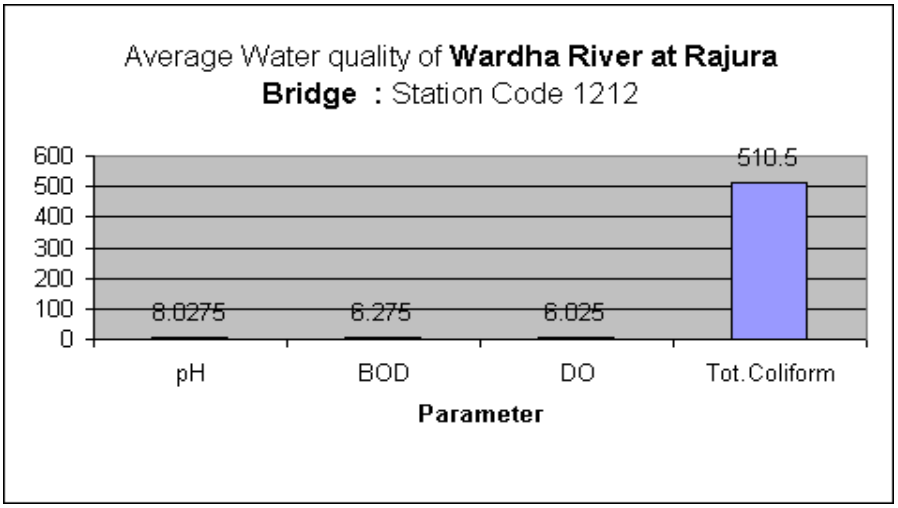

Average Water quality of **Godavari River at D/s of Nashik :** Station Code 1211
600
500
400
300
200
100
0
565.8333333
7.58
12.66666667
5.815
pH
BOD
DO
Tot.Coliform
Parameter

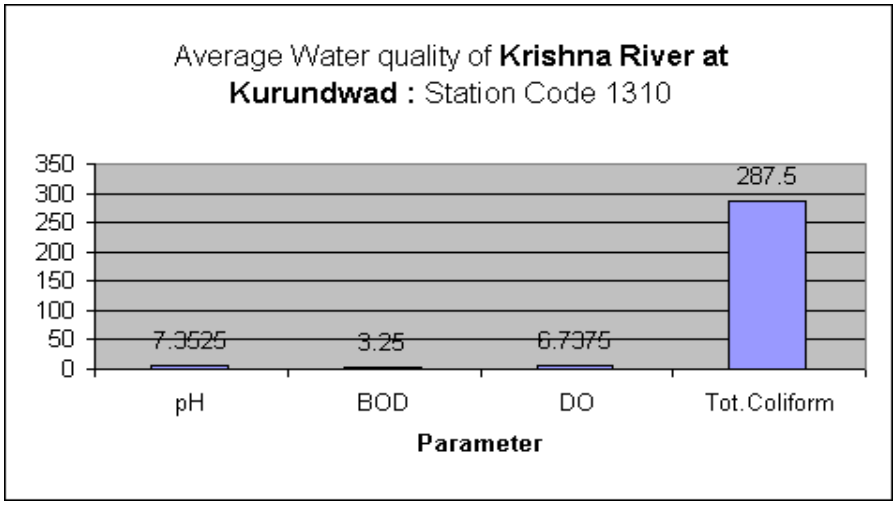

Average Water quality of **Godavari River at Nanded** : Station Code 1210
4000
3000
2000
1000
0
7.926666667
4.6
6.485
2878.333333
pH
BOD
DO
Tot.Coliform
Parameter

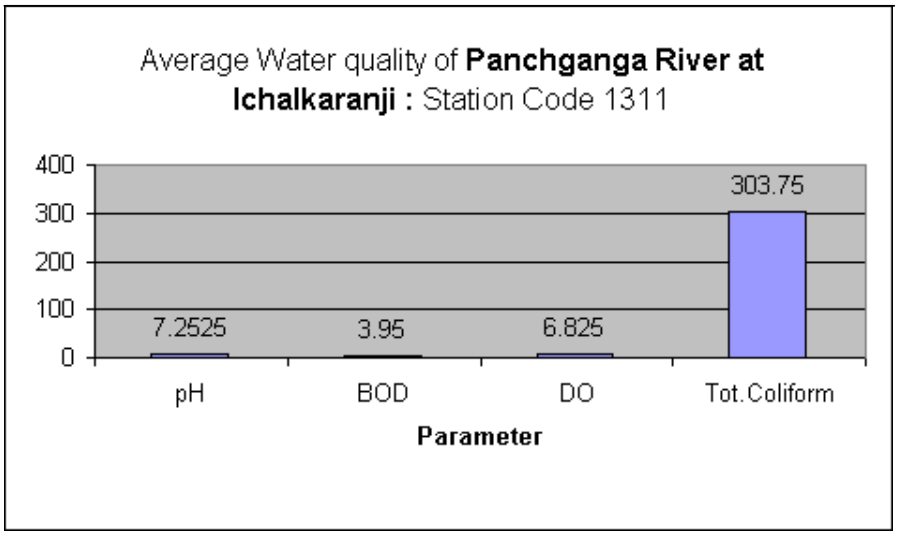

Average Water quality of **Tapi River at Bhusaval** : Station Code 1251
120
100
80
60
40
20
0
8.52
11.29285714
6.311428571
109.6666667
pH
BOD
DO
Tot.Coliform
Parameter

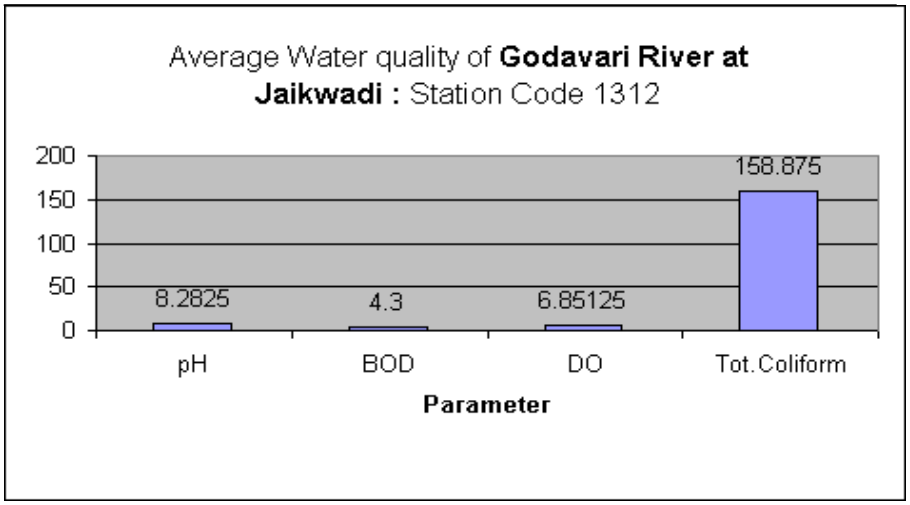

Average Water quality of **Godavari River at Raher** : Station Code 1209
250
200
150
100
50
0
7.91375
4.14
6.05125
199.75
pH
BOD
DO
Tot.Coliform
Parameter

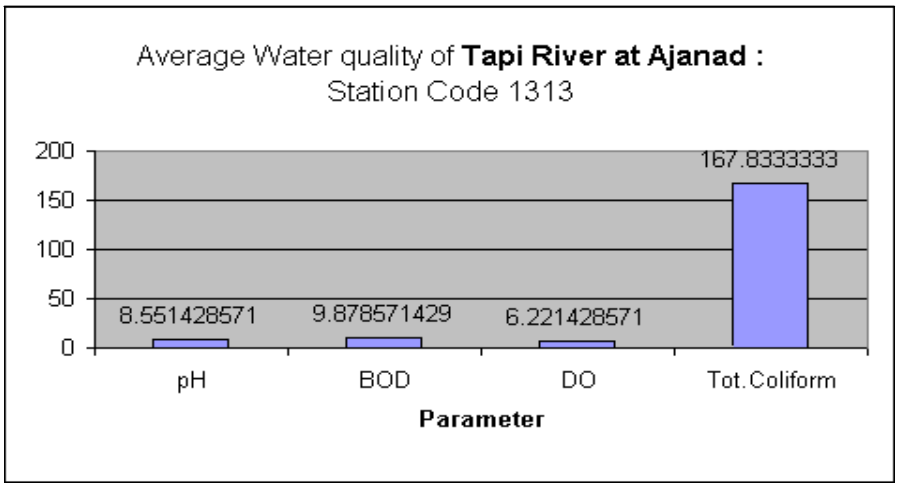

Average Water quality of **Girna River at Malegaon** : Station Code 1253
1000
800
600
400
200
0
8.3725
5.55
5.675
806.25
pH
BOD
DO
Tot.Coliform
Parameter

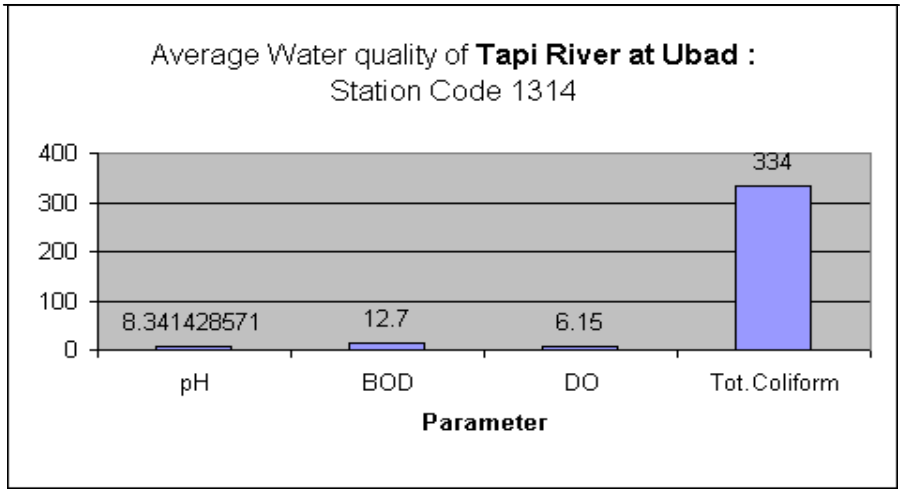

Average Water quality of **Wardha River at Rajura Bridge** : Station Code 1212
600
500
400
300
200
100
0
8.0275
6.275
6.025
510.5
pH
BOD
DO
Tot.Coliform
Parameter

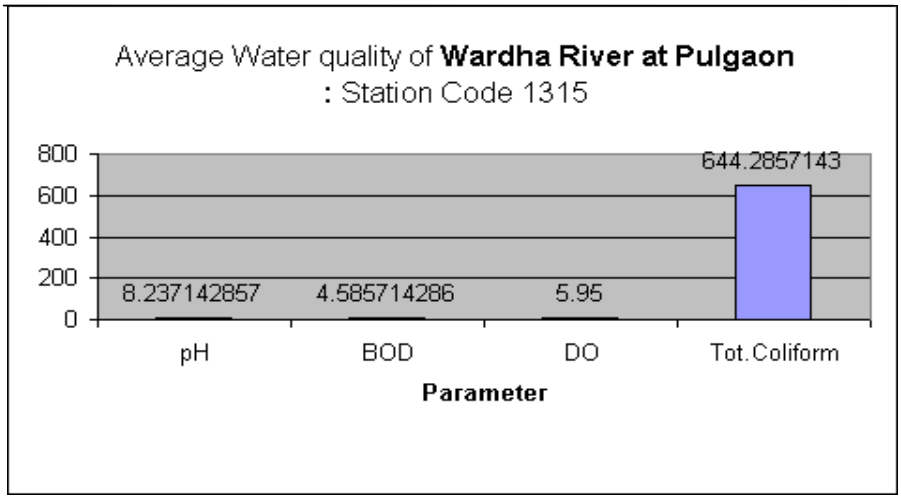

Average Water quality of **Krishna River at Kurundwad** : Station Code 1310
350
300
250
200
150
100
50
0
7.3525
3.25
6.7375
287.5
pH
BOD
DO
Tot.Coliform
Parameter

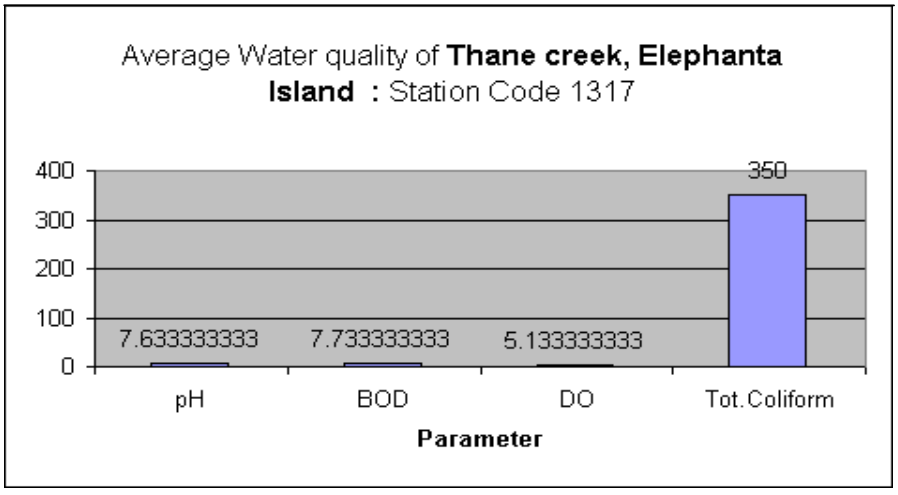

Average Water quality of **Panchganga River at Ichalkaranji :** Station Code 1311
400
300
200
100
0
303.75
7.2525
3.95
6.825
pH
BOD
DO
Tot.Coliform
Parameter

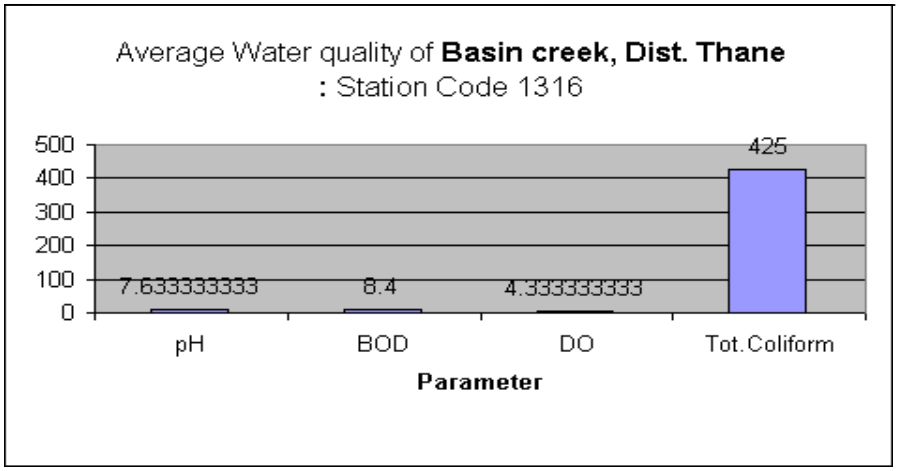

Average Water quality of **Godavari River at Jaikwadi :** Station Code 1312
200
150
100
50
0
158.875
8.2825
4.3
6.85125
pH
BOD
DO
Tot.Coliform
Parameter

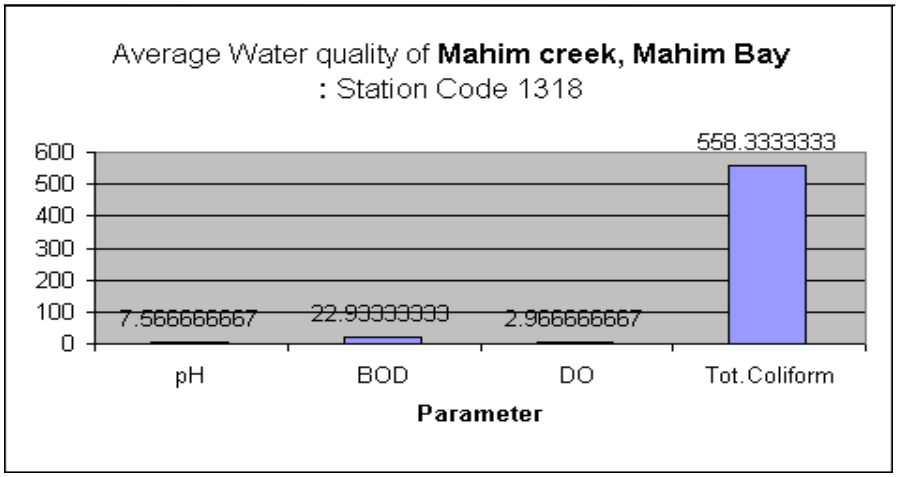

Average Water quality of **Tapi River at Ajanad :** Station Code 1313
200
150
100
50
0
167.8333333
8.551428571
9.878571429
6.221428571
pH
BOD
DO
Tot.Coliform
Parameter

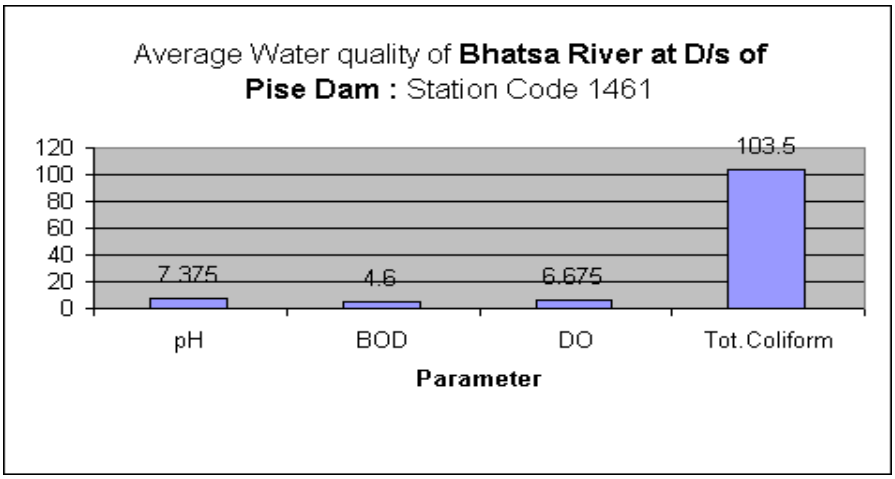

Average Water quality of **Tapi River at Ubad :** Station Code 1314
400
300
200
100
0
8.341428571
12.7
6.15
334
pH
BOD
DO
Tot.Coliform
Parameter

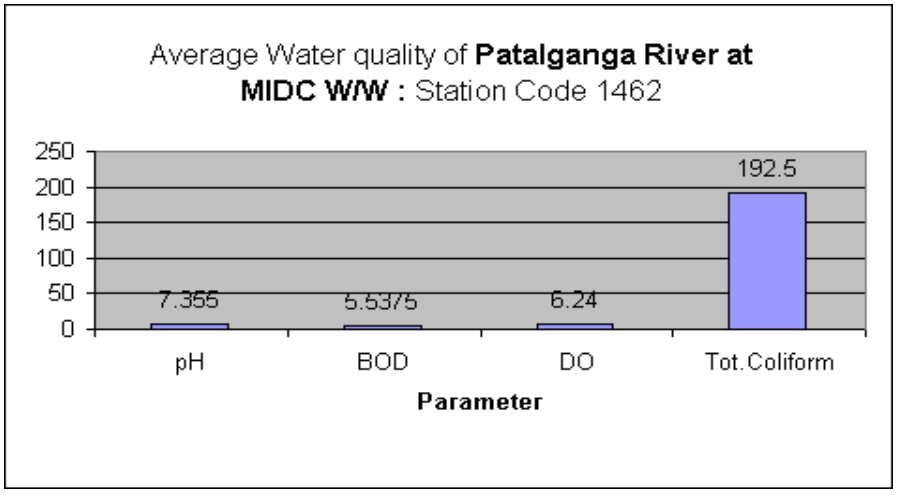

Average Water quality of **Wardha River at Pulgaon : Station Code 1315**
800
600
400
200
0
8.237142857
4.585714286
5.95
644.2857143
pH
BOD
DO
Tot.Coliform
Parameter

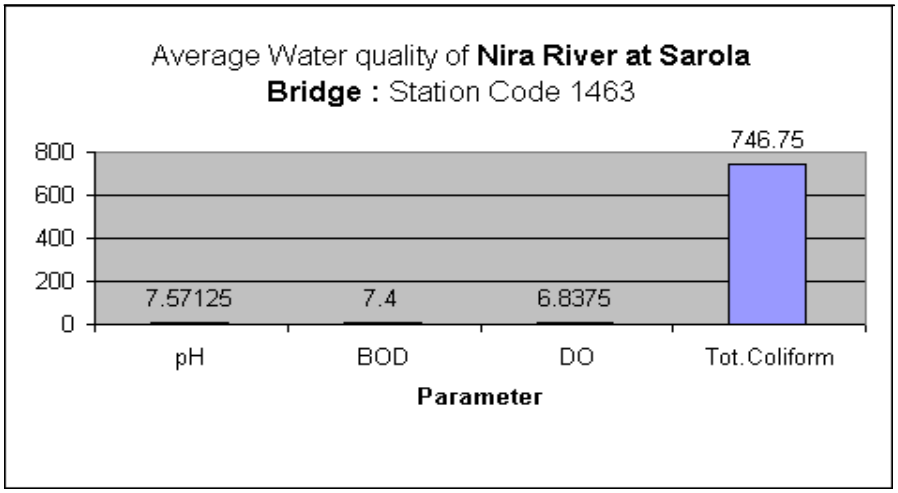

Average Water quality of **Thane creek, Elephanta Island :** Station Code 1317
400
300
200
100
0
7.633333333
7.733333333
5.133333333
350
pH
BOD
DO
Tot.Coliform
Parameter

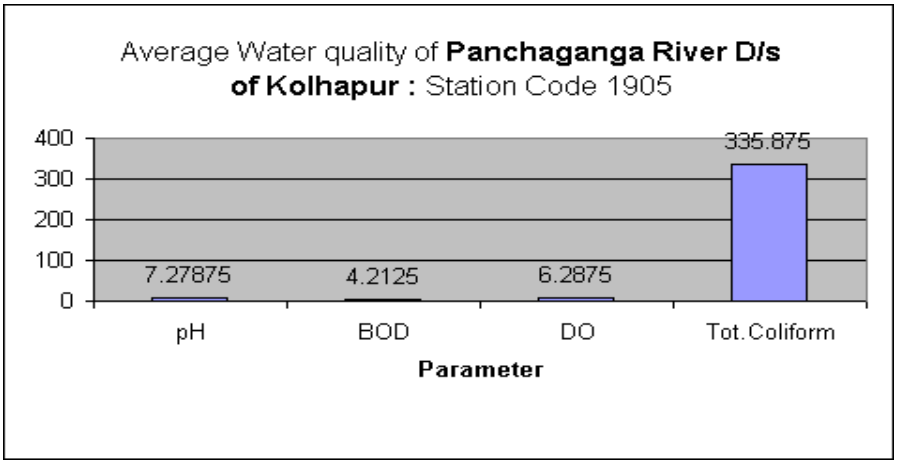

Average Water quality of **Basin creek, Dist. Thane** : Station Code 1316
500
400
300
200
100
0
7.633333333
8.4
4.333333333
425
pH
BOD
DO
Tot.Coliform
Parameter

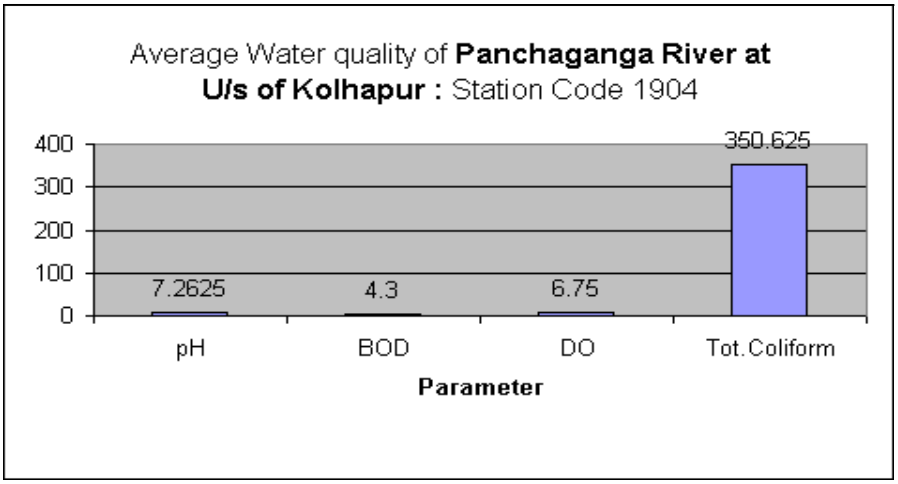

Average Water quality of **Mahim creek, Mahim Bay** : Station Code 1318
600
500
400
300
200
100
0
7.566666667
22.93333333
2.966666667
558.3333333
pH
BOD
DO
Tot.Coliform
Parameter

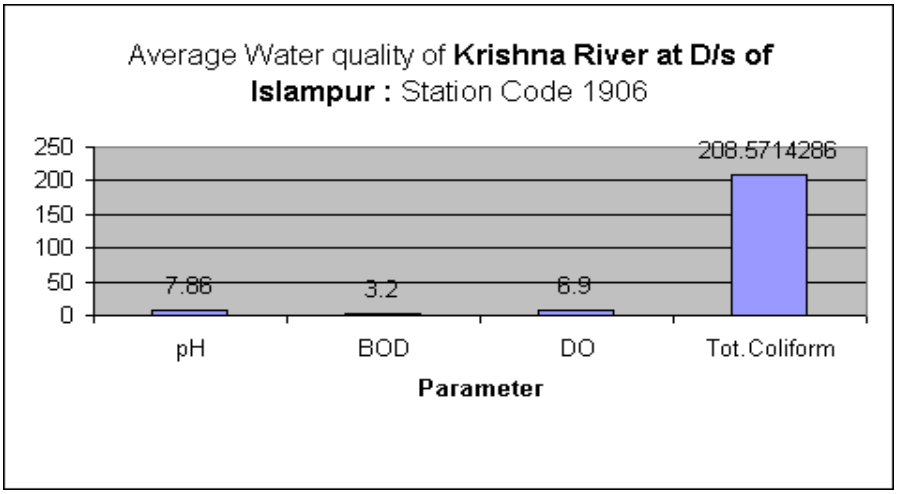

Average Water quality of **Bhatsa River at D/s of Pise Dam :** Station Code 1461
120
100
80
60
40
20
0
7.375
4.6
6.675
103.5
pH
BOD
DO
Tot.Coliform
Parameter

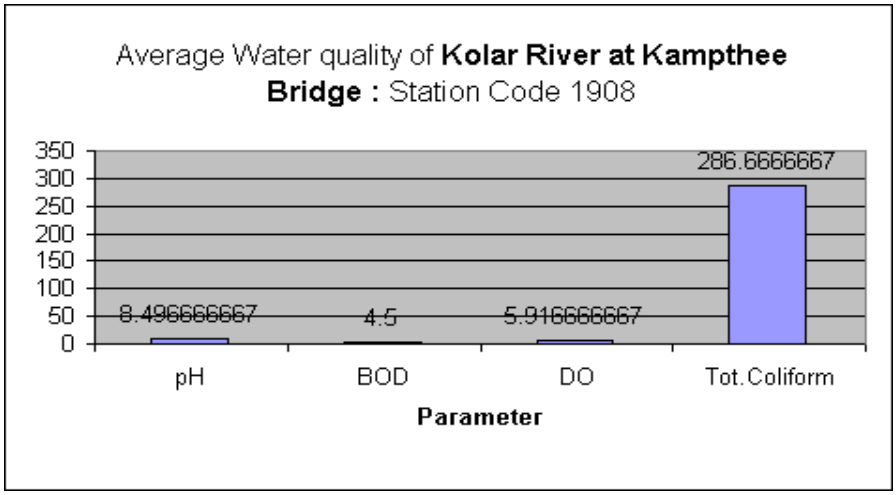

Average Water quality of **Patalganga River at MIDC W/W :** Station Code 1462
250
200
150
100
50
0
7.355
5.5375
6.24
192.5
pH
BOD
DO
Tot.Coliform
Parameter

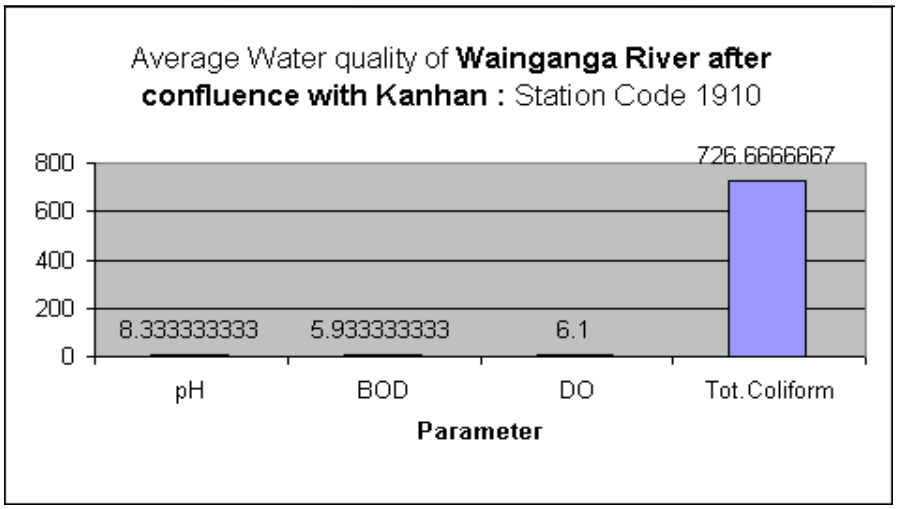

Average Water quality of **Nira River at Sarola Bridge :** Station Code 1463
800
600
400
200
0
7.57125
7.4
6.8375
746.75
pH
BOD
DO
Tot.Coliform
Parameter

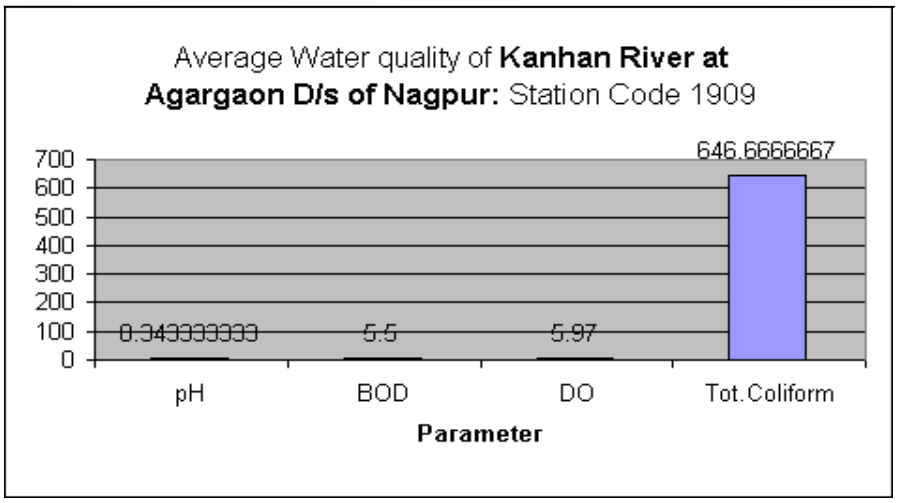

Average Water quality of **Panchaganga River D/s of Kolhapur :** Station Code 1905
400
300
200
100
0
7.27875
4.2125
6.2875
335.875
pH
BOD
DO
Tot.Coliform
Parameter

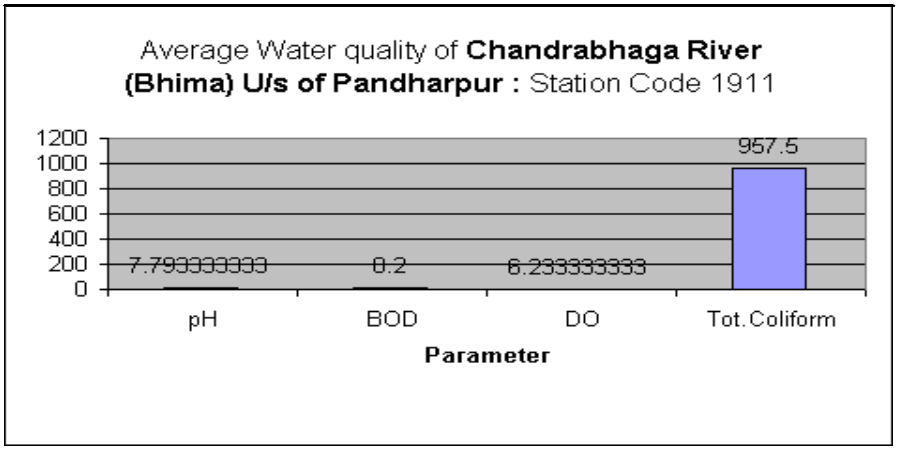

Average Water quality of **Panchaganga River at U/s of Kolhapur :** Station Code 1904
400
300
200
100
0
7.2625
4.3
6.75
350.625
pH
BOD
DO
Tot.Coliform
Parameter

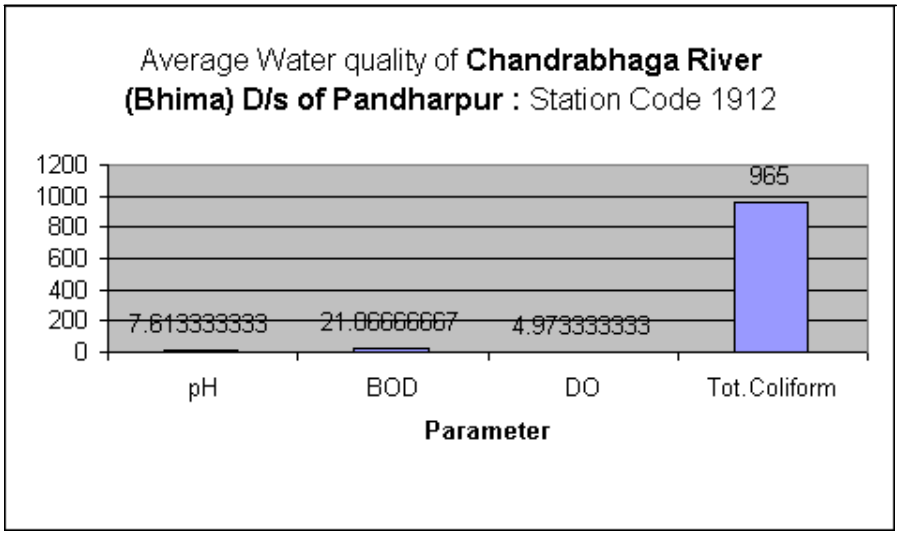

Average Water quality of **Krishna River at D/s of Islampur :** Station Code 1906
250
200
150
100
50
0
7.86
3.2
6.9
208.5714286
pH
BOD
DO
Tot.Coliform
Parameter

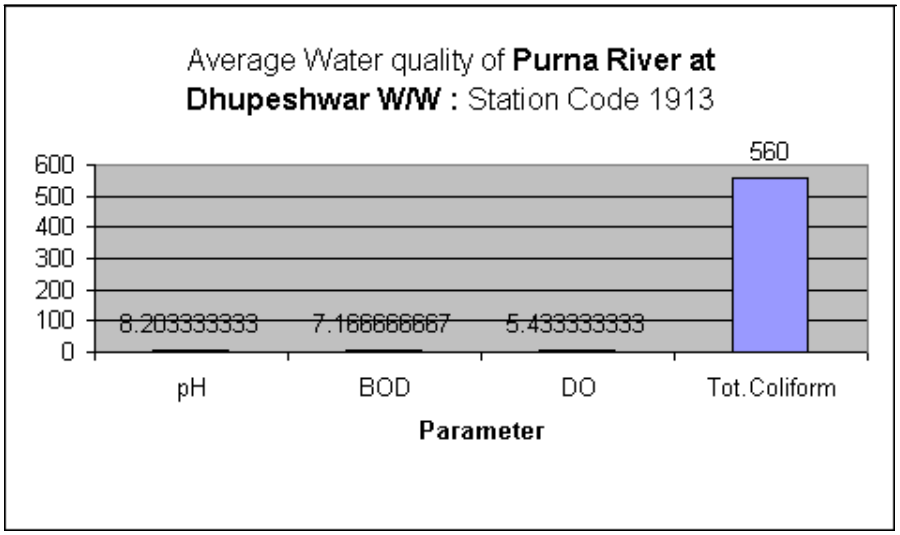

Average Water quality of **Kolar River at Kampthee Bridge :** Station Code 1908
350
300
250
200
150
100
50
0
8.496666667
4.5
5.916666667
286.6666667
pH
BOD
DO
Tot.Coliform
Parameter

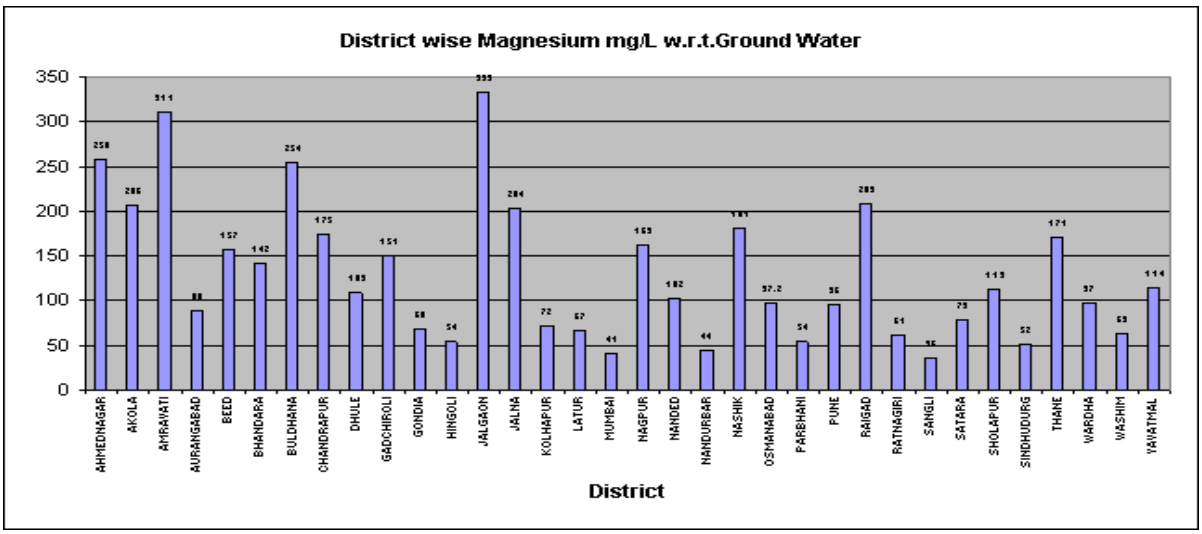

Average Water quality of **Wainganga River after confluence with Kanhan :** Station Code 1910
800
600
400
200
0
8.333333333
5.933333333
6.1
726.6666667
pH
BOD
DO
Tot.Coliform
Parameter

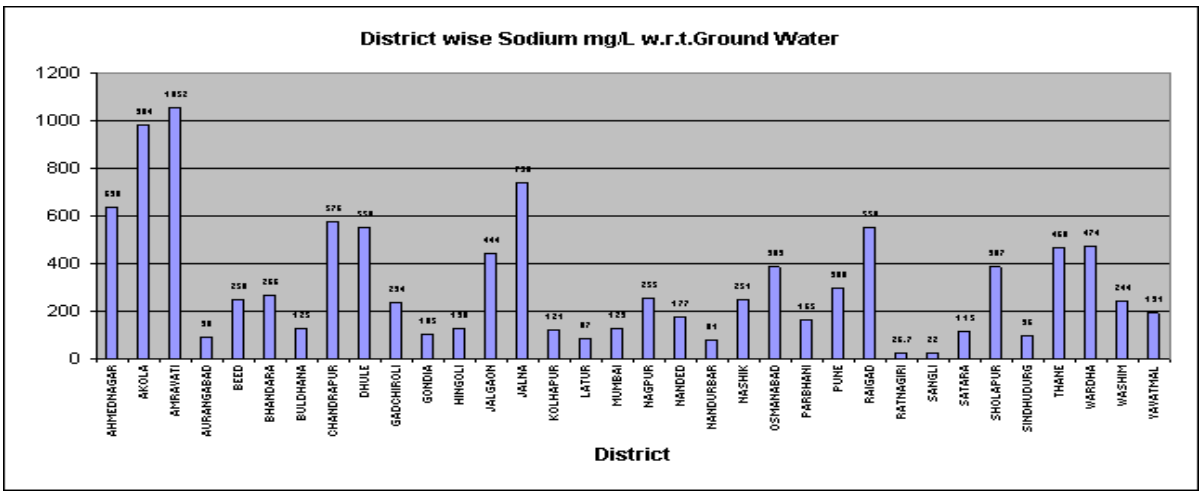

Average Water quality of **Kanhan River at Agargaon D/s of Nagpur:** Station Code 1909
700
600
500
400
300
200
100
0
8.343333333
5.5
5.97
646.6666667
pH
BOD
DO
Tot.Coliform
Parameter

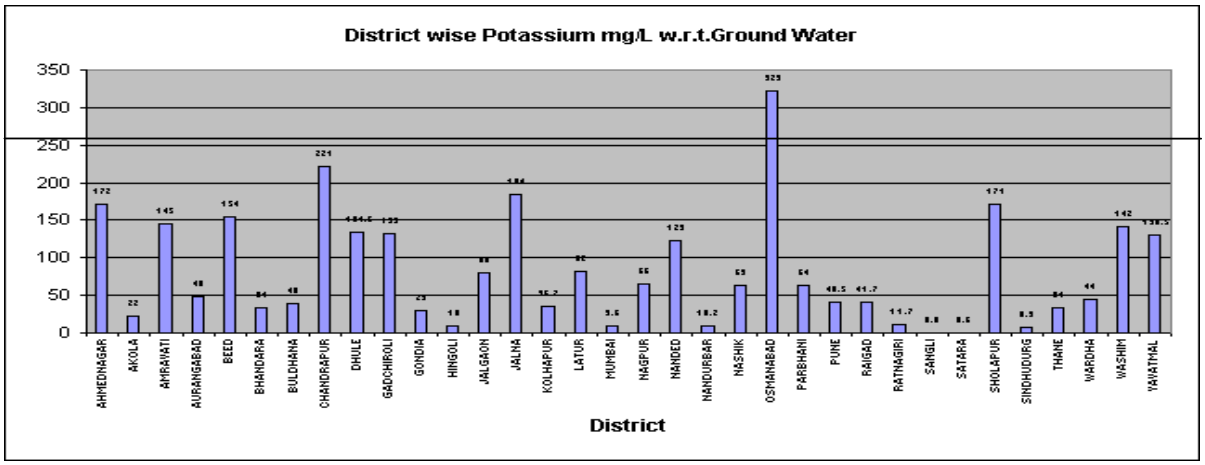

Average Water quality of **Chandrabhaga River (Bhima) U/s of Pandharpur :** Station Code 1911
1200
1000
800
600
400
200
0
7.793333333
8.2
6.233333333
957.5
pH
BOD
DO
Tot.Coliform
Parameter

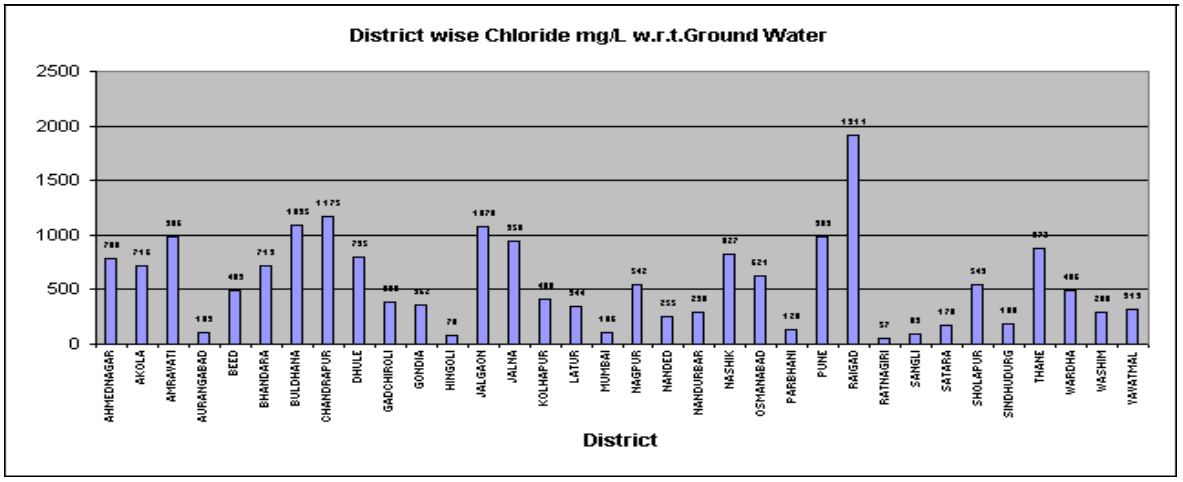

Average Water quality of **Chandrabhaga River (Bhima) D/s of Pandharpur :** Station Code 1912
1200
1000
800
600
400
200
0
7.613333333
21.06666667
4.973333333
965
pH
BOD
DO
Tot.Coliform
Parameter

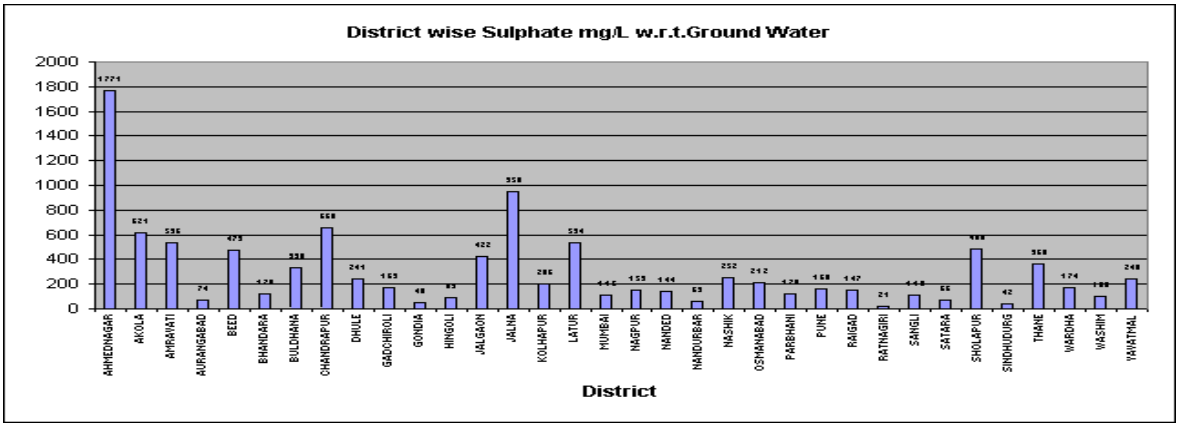

Average Water quality of **Purna River at Dhupeshwar W/W :** Station Code 1913
600
500
400
300
200
100
0
8.203333333
7.166666667
5.433333333
560
pH
BOD
DO
Tot.Coliform
Parameter

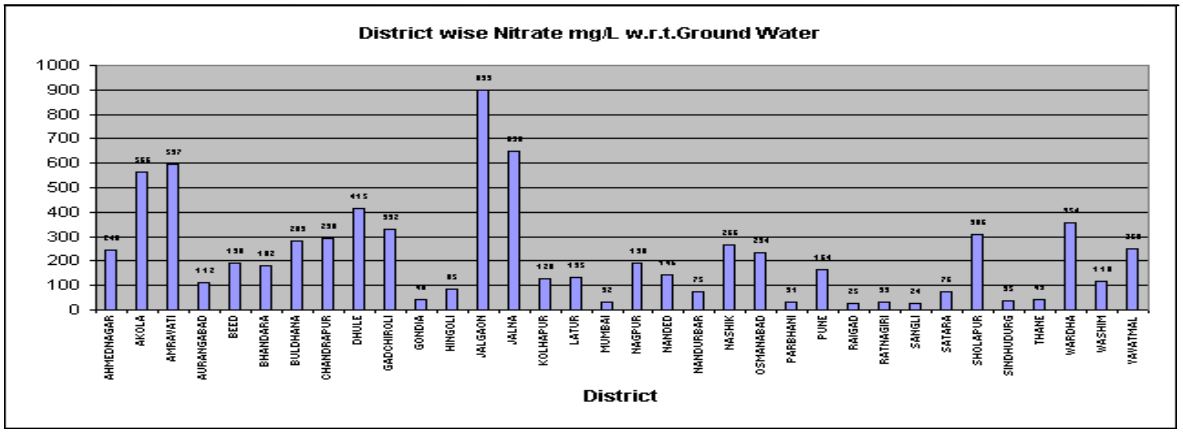

District wise Magnesium mg/L w.r.t.Ground Water
350
300
250
200
150
100
50
0
AHMEDNAGAR
AKOLA
AMRAVATI
AURANGABAD
BEED
BHANDARA
BULDHANA
CHANDRAPUR
DHULE
GADCHIROLI
GONDIA
HINGOLI
JALGAON
JALNA
KOLHAPUR
LATUR
MUMBAI
NAGPUR
NANDED
NANDURBAR
NASHIK
OSMANABAD
PARBHANI
PUNE
RAIGAD
RATNAGIRI
SANGLI
SATARA
SHOLAPUR
SINDHUDURG
THANE
WARDHA
WASHIM
YAVATMAL
District

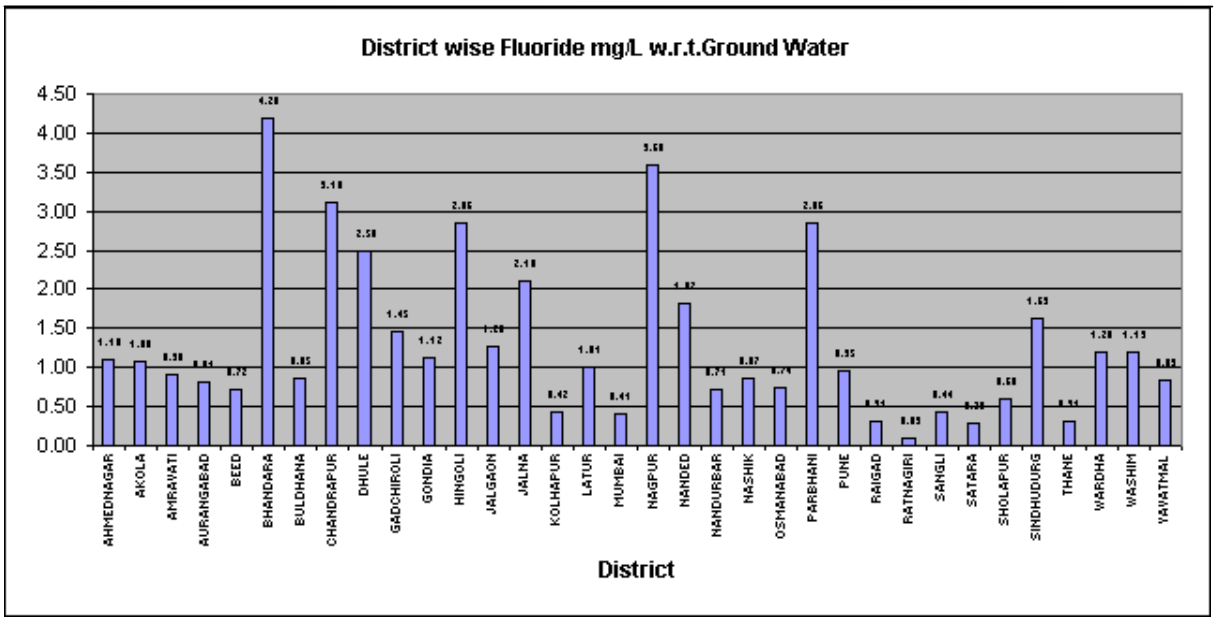

District wise Sodium mg/L w.r.t.Ground Water
1200
1000
800
600
400
200
0
AHMEDNAGAR
AKOLA
AMRAVATI
AURANGABAD
BEED
BHANDARA
BULDHANA
CHANDRAPUR
DHULE
GADCHIROLI
GONDIA
HINGOLI
JALGAON
JALNA
KOLHAPUR
LATUR
MUMBAI
NAGPUR
NANDED
NANDURBAR
NASHIK
OSMANABAD
PARBHANI
PUNE
RAIGAD
RATNAGIRI
SANGLI
SATARA
SHOLAPUR
SINDHUDURG
THANE
WARDHA
WASHIM
YAVATMAL
District


District wise Potassium mg/L w.r.t.Ground Water
350
300
250
200
150
100
50
0
AHMEDNAGAR
AKOLA
AMRAVATI
AURANGABAD
BEED
BHANDARA
BULDHANA
CHANDRAPUR
DHULE
GADCHIROLI
GONDIA
HINGOLI
JALGAON
JALNA
KOLHAPUR
LATUR
MUMBAI
NAGPUR
NANDED
NANDURBAR
NASHIK
OSMANABAD
PARBHANI
PUNE
RAIGAD
RATNAGIRI
SANGLI
SATARA
SHOLAPUR
SINDHUDURG
THANE
WARDHA
WASHIM
YAVATMAL
District


District wise Chloride mg/L w.r.t.Ground Water
2500
2000
1500
1000
500
0
AHMEDNAGAR
AKOLA
AMRAVATI
AURANGABAD
BEED
BHANDARA
BULDHANA
CHANDRAPUR
DHULE
GADCHIROLI
GONDIA
HINGOLI
JALGAON
JALNA
KOLHAPUR
LATUR
MUMBAI
NAGPUR
NANDED
NANDURBAR
NASHIK
OSMANABAD
PARBHANI
PUNE
RAIGAD
RATNAGIRI
SANGLI
SATARA
SHOLAPUR
SINDHUDURG
THANE
WARDHA
WASHIM
YAVATMAL
District


District wise Sulphate mg/L w.r.t.Ground Water
2000
1800
1600
1400
1200
1000
800
600
400
200
0
AHMEDNAGAR
AKOLA
AMRAVATI
AURANGABAD
BEED
BHANDARA
BULDHANA
CHANDRAPUR
DHULE
GADCHIROLI
GONDIA
HINGOLI
JALGAON
JALNA
KOLHAPUR
LATUR
MUMBAI
NAGPUR
NANDED
NANDURBAR
NASHIK
OSMANABAD
PARBHANI
PUNE
RAIGAD
RATNAGIRI
SANGLI
SATARA
SHOLAPUR
SINDHUDURG
THANE
WARDHA
WASHIM
YAVATMAL
District


District wise Nitrate mg/L w.r.t.Ground Water
1000
900
800
700
600
500
400
300
200
100
0
AHMEDNAGAR
AKOLA
AMRAVATI
AURANGABAD
BEED
BHANDARA
BULDHANA
CHANDRAPUR
DHULE
GADCHIROLI
GONDIA
HINGOLI
JALGAON
JALNA
KOLHAPUR
LATUR
MUMBAI
NAGPUR
NANDED
NANDURBAR
NASHIK
OSMANABAD
PARBHANI
PUNE
RAIGAD
RATNAGIRI
SANGLI
SATARA
SHOLAPUR
SINDHUDURG
THANE
WARDHA
WASHIM
YAVATMAL
District


District wise Fluoride mg/L w.r.t.Ground Water
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
AHMEDNAGAR
AKOLA
AMRAVATI
AURANGABAD
BEED
BHANDARA
BULDHANA
CHANDRAPUR
DHULE
GADCHIROLI
GONDIA
HINGOLI
JALGAON
JALNA
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OSMANABAD
PARBHANI
PUNE
RAIGAD
RATNAGIRI
SANGLI
SATARA
SHOLAPUR
SINDHUDURG
THANE
WARDHA
WASHIM
YAVATMAL
District

CHAPTER – VIII

RECOMMENDATIONS / REMEDIAL MEASURES

In order to prevent water pollution and for conservation of water and create mass awareness in general public regarding surface and ground water quality aspects, recommendation /remedial measures are described as below.

8.1 Qualitative/Technical:

1) Domestic effluents may be treated and disinfected before discharging.

2) Effluents from the non-point sources may be identified. These are required to be collected and treated.

3) Tree plantation may be done on banks of rivers to minimize soil erosion and to improve the area aesthetically.

4) The artificial recharge of ground water through integrated watershed management programme and rainwater harvesting will help to improve the ground water quality in the area where the problem exists.

8.2 Administrative:

1) Non-industrial activities such as Effluent Treatment Plants, Composting,Vermiculture, Animal stalls, Cattle and Goat pens, Animal husbandry, Fish farming, Dumping of ash, Solid waste may not be allowed in 'No Development Zone' (3 km on either side of river) of A-I stretch of river. (Source to first dam)

2) No industries may be allowed in 'No Development Zone'. Industries are to be set up at distances specified by Pollution Control Board. River policy criteria (MPCB) may to be fulfilled.

3) Classification, zoning of land for designated uses such as agriculture, forestry, green areas, industrial activities, watersheds and human settlements based on assessment of environmental considerations is necessary

4) Countrywide campaign to minimize soil and runoff losses by carrying out extensive works like contour trenching, contour bunding, terracing and watersheds needs strengthening.

5) Measures for water conservation, recycling and optimal conjunctive use of surface and ground water for specific uses are necessary.

6) Classification, zoning and regulations for monitoring the quality of the water bodies to protect and enhance their capabilities to support the various designated uses may be implemented

7) Measures for sustainable use of water resources are necessary

8) Farmers may be encouraged to use advanced irrigation system like drip irrigation in order to conserve water and prevent erosion of the top soil.

9) Farmers in the catchment area should be educated against use of extensive amount of pesticides and chemical fertilizers. They should be encouraged to use organic manures.

10 To create Environmental consciousness through education and mass awareness programmes may be planned.

11) Besides the regular ground water quality monitoring, special studies should be undertaken on micro-level basis where ground water quality has undergone deterioration to ascertain the reasons, extent and remedial measures thereafter.

12) The lack of facilities and awareness for proper disposal of waste and wastewater is mainly causing the ground water quality deterioration in the state. Hence, it is suggested that people in the rural and urban parts of the State should be made aware about the pollution of the ground water and its impacts. Strict regulations must be observed to stop pollution of ground water.

8.3 Legal:

1) Environmental Impact Assessment studies shall be carried out for all Developmental projects right from planning stage and integrate it with their cost benefit considerations.

2) Legislative measures are must to check over exploitation of ground water for various uses as per Maharashtra Groundwater (Regulation for Drinking Water Purpose) Act, 1993

Status Report on Water Quality of Water Bodies and ground water in Maharashtra
for the year 2004-2005

ANNEXURES

ANNEXURE-1

SIGNIFICANCE OF WATER QUALITY PARAMETERS

1. Temperature	It affects both chemical & biological reactions in the water. High temperature reduces solubility of gases & amplifies taste & odour. At high temp. , metabolic activity of organisms increases requiring more oxygen but at the same time the solubility of oxygen decreases, thus increasing the stress. Change in temp occurs due to sunlight intensity, climate, industrial, domestic & irrigation waste.
2. Colour	Highly coloured waters are objected on aesthetic grounds. Colour is imparted due to humic / fulvic acids, metallic ions such as iron & manganese, suspended matter, phytoplankton, industrial wastes etc.
3. Odour	It is due to dissolved organic impurities caused by living & decaying organisms & accumulation of gases like ammonia & hydrogen sulfide. Algae also impart odours. Chemicals added to water such as chlorine also add to the odour.
4. Turbidity	It is caused by day, silt, organic matter & microorganisms Determination of turbidity is important for its removal due to coagulation, filtration in water treatment plants.
5. Conductivity	It is a rapid measure of the total dissolved solids. It is an important parameter for determining suitability of water & wastewater for irrigation.
5. Dissolved Solids	They denote various kinds of minerals present in the water & also organic substances in case of polluted waters. Dissolved solids in higher concentration reduce its palatability. Plants are also adversely affected.
7. pH	pH of water gets drastically changed due to disposal of waste, exposure to air, biological activity & temperature changes. A lower value below 4 produces sour taste & higher value above 8.5 an alkaline taste. Extreme pH can result in rapid fish kills & alteration in flora and fauna.
8. Alkalinity	It is caused due to carbonates & bicarbonates. In polluted waters, silicates, phosphates, borates, humates also contribute to Alkalinity of water. Alkalinity value is important for calculating alum dosage.
9.Dissolved Oxygen	It is the most important parameter in water quality assessment. It is essential to maintain presence of higher forms of biological life in the water. Low oxygen in water can kill fish. Fish require oxygen concentration of 2 to 5 mg/L depending on species. In waters heavily contaminated with organic matter,

	dissolved oxygen disappears. Oxygen saturated waters have a pleasant taste.
10. B.O.D.	It is the measure of biodegradable organic matter. If BOD is high, there is depletion of DO.
11. C.O.D.	It is the measure of chemically oxidizable organic matter.
12. Ammonia	Occurrence of ammonia in the waters can be accepted as the chemical evidence of organic pollution. Sewage has large quantities of nitrogenous matter, thus its disposal increases the ammonia content of water. If only ammonia is present, pollution by sewage is very recent. The occurrence of Nitrite with ammonia indicates that some time has elapsed since pollution occurred. If only nitrate is present, a long time has passed after sewage pollution has taken place. High conc. of ammonia is toxic to man. Toxicity of ammonia increases with high pH.
13. Nitrite	It indicates recent faecal pollution. It gets converted either into ammonia or nitrate. High concentration of nitrite may cause 'Blue baby ' disease in infants.
14. Nitrate	It is the highest oxidized form of nitrogen. Domestic sewage & industrial waste contribute to nitrates. Run-off from agricultural fields also contribute nitrate. Ground waters can get contaminated by sewage rich in nitrates. Nitrates can cause blue baby disease if above 40 mg/l .High concentration is useful in agriculture but their entry into the water increases algal growth & eutrophication.
15. Phosphorus	The major sources of phosphorous are domestic sewage, detergents, fertilizers & industrial effluents. Thus a high concentration is indicative of pollution. It increases the growth of algae & thus eutrophication.
16. Sulfate	Discharge of domestic & industrial waste increases its concentration. It also occurs naturally in water. Rainwater has high conc. of Sulphate in areas of high air pollution. Sulphate produces objectionable taste above 300 mg/l.
17. Sulphide	Contributed due to organic pollution. It has objectionable odour and hence decreases aesthetic value. Hydrogen Sulfide has toxic effects on aquatic organisms. It is corrosive. It also promotes certain bacteria responsible for clogging of pipes.
18. Chlorides	They occur naturally in waters. Discharge of sewage contributes to chloride.

	Therefore chlorides serve as an indicator of pollution by sewage. It produces salty taste.
19. Calcium	It is found naturally in waters. Disposal of sewage & industrial wastes are important sources of calcium. It has no hazardous effects on human health. High concentration is not desirable for washing & bathing due to suppression of lather formation.
20. Magnesium	It occurs naturally. Sewage & industrial waste also contribute to it. High concentration renders water unpalatable & increases hardness of water.
21. Sodium	It occurs naturally. Industrial & Domestic Waste contributes to it. High concentration can be related to cardiovascular diseases. High concentration affects soil permeability & texture.
22.Heavy Metals	Such as chromium cadmium, lead, copper, mercury, arsenic in high conc. have toxic effects on human body.
23.Biological parameters	In water receiving sewage, pathogenic organisms may be present. The bacteria causing cholera, typhoid & dysentery may be present in sewage polluted water. Polluted water also contains several pathogenic viruses like that of jaundice & poliomyelitis. Protozoan diseases like amoebic dysentery are caused by ingesting polluting water. Besides pathogens, unwanted biological growth of algae & fungi are of importance. They lead to eutrophication & hence hinder recreation & spoil aesthetic value.

Drinking Water Specifications (IS 10500)				
Sr.No.	**Substances or Characteristic**	**Requirement (Desirable Limits)**	**Permissible Limits in the Absence of Alternate Source**	**Units**
1	Colour, Max	5	25	Hazen
2	Odour	Unobjectionable	-	-
3	Taste	Agreeable	-	-
4	Turbidity, Max.	5	10	NTU
5	pH Value	6.5-8.5	6.5 to 8.5	-
6	Total hardness (as $CaCO_3$), Max	300	600	mg/l
7	Iron (as Fe), Max	0.3	1	mg/l
8	Chlorides (as Cl), Max	250	1000	mg/l
9	Residual, free chlorine, Min	0.2	-	mg/l
10	Dissolved solids, Max	500	2000	mg/l
11	Calcium (as Ca), Max	75	200	mg/l
12	Copper (as Cu), Max	0.05	1.5	mg/l
13	Manganese (as Mn), Max	0.1	0.3	mg/l
14	Sulphate (as SO_4), Max	200	400	mg/l
15	Nitrate (as NO_3), Max	45	100	mg/l
16	Fluoride (as F), Max	1	1.5	mg/l
17	Phenolic compounds (as C_6H_5OH), Max	0.001	0.002	mg/l
18	Mercury (as Hg), Max	0.001	0.001	mg/l
19	Cadmium (as Cd), Max	0.01	0.01	mg/l
20	Selenium (as Se), Max	0.01	0.01	mg/l
21	Arsenic (as As), Max	0.05	0.05	mg/l
22	Cyanide (as CN), Max	0.05	0.05	mg/l
23	Lead (asPb), Max	0.05	0.05	mg/l
24	Zinc (as Zn), Max	5	5	mg/l
25	Anionic detergents (as MBAS), Max	0.2	0.2	mg/l
26	Chromium (as $Cr+^6$), Max	0.05	0.05	mg/l
27	Poly-nuclear aromatic hydrocarbon (PAH),	-	-	g/l
28	Mineral oil, Max	0.01	0.03	mg/l
29	Pesticides, Max	Absent	0.001	mg/l
30	Radioactive materials	-		
	a) Alpha emitters,Max	-	0.1	Bq/l
	b) Beta emitters,Max.	-	1	pci/l
31	Alkalinity, Max	200	600	mg/l
32	Aluminium (as Al), Max	0.03	0.2	mg/l
33	Boron, Max	1	5	mg/l
34	Magnesium ,Max	30	100	mg/l
35	Total Coliforms	Absent	10	per 100 ml
36	E.coli	Absent	Absent	per 100 ml

Standards for Bacteriological Examination as per IS 10500 : 1991

a) Throughout any year, 95 percent of samples should not contain any coliform organisms in 100ml;
b) No sample should contain E. coli in 100 ml;
c) No sample should contain more than 10 coliform organisms per 100ml; and
d) Coliform organisms should not be detectable in 100 ml of any two consecutive samples.

ANNEXURE-3

Water Quality Criteria (C. P. C. B.)

Designated-Best-Use	Class of water	Criteria
Drinking Water Source without conventional treatment but after disinfections	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 20^{o}C 2mg/l or less
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 20^{o}C 3mg/l or less
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 20^{o}C 3mg/l or less
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
Irrigation, Industrial Cooling, Controlled Waste disposal	E	1. pH between 6.0 to 8.5 2. Electrical Conductivity at 25^{o}C micro mhos/cm Max.2250 3. Sodium absorption Ratio Max. 26 4. Boron Max. 2mg/l
	Below-E	Not Meeting A, B, C, D & E Criteria

Water Quality Standards for Best Designated Usages (MPCB)

Category of Fresh Water	A - I	A-II	A-III	A-IV
Best Usage	Unfiltered Public water supply after approved disinfection	Public water supply with approved treatment equal to coagulation, sedimentation & disinfection.	Not fit for human consumption, Fish & Wildlife Propagation.	Fit for Agriculture, Industrial cooling & process water.
Chemical Qualities: Maximum allowable concentration				
1. Toxic Substances				
Arsenic (As)	0.3 mg/l	0.3 mg/l	1.0 mg/l	0.1 mg/l
Cadmium (Cd)	0.01 mg/l	0.01 mg/l	-	-
Chromium (Cr)	0.05 mg/l	0.05 mg/l	0.05 mg/l	0.2 mg/l
Cyanide (CN)	0.05 mg/l	0.1 mg/l	0.05 mg/l	0.2 mg/l
Lead (Pb)	0.1 mg/l	0.1 mg/l	-	0.1 mg/l
Boron (B)	-	-	-	0.2 mg/l
Mercury (Hg)	0.001 mg/l	0.001 mg/l	0.001 mg/l	2.0 mg/l
Gross alpha activity	3 PCI/l	10-9 uc/ml	3 PCI/l	3 PCI/l
Gross Beta activity	30 PCI/l	10-8 uc/m	30 PCI/l	30 PCI/l
2. Substances affecting health				
Fluoride (F)	1.5 mg/l	1.5 mg/l	-	1.0 mg/l
Nitrates (NO3)	45 mg/l	45 mg/l	-	-
3. Substances affecting the portability of water				
pH	6.5 to 8.5	6.0 to 8.5	6.5 to 9.0	6.5 to 9.0
T.D.S.	-	T.D.S.	T.D.S.	-.
Total Solids	1500 mg/l.	1500 mg/l.	-.	-
Total Suspended Solids	25 mg/l	-	-	-
Total Hardness (Caco3)	50 mg/l	-	-	-
Total Residual Chlorine	-	-	-	-
Electrical conduct at 25^0. C	-	-	1000 x 10-6 mhos	3000 x 10-6 mhos
Free Carbon Di Oxide	-	-	12 mg/l	-
Free Ammonical Nitrogen	-	-	1.2 mg/l	-
Oil & Grease	-	-	0.1 mg/l	-
Pesticides	-	-	0.02 mg/l	-

Biotic Index	-	-	6.0 mg/l	-
Total Ammonical Nitrogen	1.5 mg/l	1.5 mg/l	-	50 mg/l
Chlorides (Cl)	600 mg/l	600 mg/l	-	600 mg/l
Sulphates	400 mg/l	400 mg/l	-	1000 mg/l
Copper (Cu)	1.5 mg/l	1.5 mg/l	-	-
Manganese (Mn)	0.5 mg/l	3.0 mg/l	-	-
Iron (Fe)	1.0 mg/l	5.0 mg/l	-	-
Sodium	-	-	-	-
Zinc (Zn)	15.0 mg/l	1.5 mg/l	5.0 mg/l	5.0 mg/l
Phenolic Compounds	0.002 mg/l	0.002 mg/l	0.05 mg/l	-
Alkyl Benzene sulphates	1.0 mg/l	1.0 mg/l	-	-
Mineral Oil	0.3 mg/l	0.3 mg/l	-	-
Ammonia	1.5 mg/l	1.5 mg/l	-	-
B.O.D. (5 days 20 . C)	2.0 mg/l (Monthly average of at least 10 samples)	5.0 mg/l(Monthly average of at least 10 samples)	10 mg/l	30 mg/l
C.O.D.	-	-	-	150 mg/l
D.O.	Not less than 5 mg/l(Monthly average of 100 samples)	4.0 mg/l	Not less than 3 mg/l	Not less than 2 mg/l
Bacteriological Standards :	Coliform Bact. 250	Not greater than 5000		
(MPN/100)				

ANNEXURE-5

Drinking Water Guidelines as per WHO

Bacteriological Quality of Dringking Water [a]	
Organisms	**Guidelines**
All water intended for drinking E.coli or thermotolerant coliform bacteria [b,c]	Must not be detectable in any 100-ml sample
Treated water entering the distribution system E coli or thermotolerant coliform Bacteria [b] Total coliform bacteria	Must not be detectable in any 100-ml sample Must not be detectable in any 100-ml sample
Treated water in the distribution system E.coli or thermotolerant coliform Bacteria Total coliform bacteria	Must not be detectable in any 100-ml sample Must not be detectable in any 100-ml sample. In the case of large supplies, where sufficient samples are examined, must not be present in 95% of samples taken throughout any 12-month period.

Immediate investigative action must be taken if either E.coli or total coliform bacteria are detected. The minimum action in the case of total coliform bacteria is repeat sampling; if these bacteria are detected in the repeat sample, the cause must be determined by immediate further investigation.

Although E.coli is the more precise indicator of faecal pollution, the count of thermo tolerant coliform bacteria is an acceptable alternative. If necessary, proper confirmatory tests must be carried out. Total coliform bacteria are not acceptable indicators of the sanitary quality of rural water supplies, particularly in tropical areas where many bacteria of no sanitary significance occur in almost all untreated supplies.

It is recognised that, in the great majority of rural water supplies in developing countries, faecal contamination is widespread. Under these conditions, the national surveillance agency should set medium-term targets for progressive improvement of water supplies, as recommended in Volume 3 of Guidelines for drinking water quality.

Drinking Water Guidelines as per WHO

Chemicals of health significance in drinking water

Inorganic Constituents

	Guideline Value (mg/L)	Remarks
Antimony	0.05(P)[a]	
Arsenic	0.01[b](P)	For excess skin cancer risk of $6x10^{-4}$
Barium	07	
Berylium		NAD[c]
Boron	0.5(P)[a]	
Cadmium	0.003	
Chromium	0.05(P)	
Copper	2(P)	Based on acute gastrointestinal effects.
Cyanide	0.07	
Fluoride	1.5	Climatic conditions, volume of water consumed, and intake from other sources should be considered when setting national standards
Lead	0.01	It is recognized that not all water will meet the guideline value immediately; meanwhile, all other recommended measures to reduce the total exposure to lead should be implemented
Manganese	0.5(P)	ATO
Mercury(total)	0.001	
Molybdenum	0.07	
Nickel	0.02	
Nitrate (as NO_3^-)	50(acute)	The sum of the ratio of the
Nitrite (as NO_2^-)	3(acute)	Concentration of each to its respective(acute) guideline value should not exceed 1
Selenium	0.01	
Uranium	0.002(P)	

ANNEXURE-7

CLASSIFICATIONS OF FRESH WATER ON BEST DESIGNATED USES

ANNEXURE-7-A

CLASSIFICATION OF FRESH WATER ON DESIGNATED USES

Sr.No.	Classification	Designated Best Uses
Fresh Waters-		
1	A-I	Drinking water source without conventional treatment but after disinfection. Point from where the river originates up to first Designated / notified Dam / Weir.
2	A-II	Drinking water source with conventional treatment followed by disinfection. River stretch below first designated / notified Dam / Weir up to A-Ill / A-IV Class of waters
3	A-III	Fish & Wild Life Propagation
4	A-IV	Agriculture, Industrial cooling & Process

CRITERIA FOR SITING OF INDUSTRIES WITH REFERENCE TO CLASSIFICATION OF RIVER ZONES

ANNEXURE 7-B

CRITERIA FOR SITING OF INDUSTRIES WITH REFERENCE TO CLASSIFICATION OF RIVER ZONES

Sr.No.	Classification	Criteria	
	Fresh Water		
1	A-I	(a) 3 Kms. on the either side of river.	No Development zone for any type of Industries. Only specified Non-Industrial listed activities are allowed.
		(b) From 3 Kms. to 8 Kms from river (H.F.L.) on either side.	Classified Green and Orange category of Industries irrespective of Investment, with requisite pollution control devices.
		(c) Beyond 8 Kms. from river (H.F.L.) on either side	Any type of industry with requisite pollution control devices
2	A-II	(a) 1 Km. on either side of river (H.F.L.)	No development zone. Only specified Non-Industrial Listed activities are allowed.
		(b) 1 km. to 2 Kms on either side.	Classified Green & Orange category of industries irrespective of investment with requisite pollution control devices.
		(c) Beyond 2 Kms	Any type of industry with requisite pollution control devices.

3	A-III	(a) - Up to ½ Km. on either side.	No development zones for any type of industries. Only specified Non - Industrial Listed activities are allowed.
4	A-IV	(a) Between ½ to 1 km on either side of river.	Classified Green & orange category of industries irrespective of investment, with requisite pollution control devices.
		(b) Beyond 1 Km	Any type of industry with requisite pollution control devices.

Note:-

i) Distances mentioned in the policy note above are shortest distances measured as the crow flies.

ii) High Flood Level (H.F.L.) of river will be considered as bank of the river for measuring the distances.

iii) If the ridge line is nearer than prescribed zone boundary, restriction apply up to the ridge line.

iv) Arrangement for pollution control shall be full proof irrespective of the location.

v) In 'No Development Zone', the permissible activities and non-permissible activities are separately prescribed.

vi) Categorisation of industries is suggestive in nature & may be reviewed and modified by the Board, from time to time.

vii) Existing industries in 'Non-Confirming Zone' will be allowed to continue with adequate pollution control arrangements. Expansion, diversification, modernization, substitution shall be allowed subject, to reduction in pollution load at source.

viii) This does not absolve the Project Proponent from observing any other Rules / Regulations applicable in specified areas like Coastal Regulation Zone / Bhatsa River Basin Etc.

ix) Cases in pipe line would be dealt on merits of each case and would be considered beyond a distance of 500 mtrs. from H.F.L. as per the prevailing policy.

x) The above classification also covers Lakes and other water bodies, excluding underground water sources.

xi) Development activities in costal areas will continue to be regulated by Ministry of Environment & forest's notification (CRZ Notification) dated 19.02.1991.

ANNEXURE 7-C

LIST OF ACTIVITIES ALLOWED / DISALLOWED IN 'NO DEVELOPMENT ZONE'

Suggestive list of Non- Industrial Activities which can be allowed in 'No Development Zone'.

1) Fuel Wood Growing
2) Furniture & Structural Wood Growing
3) Bamboo Growing
4) Grass & Fodder Growing
5) Sericulture without Processing
6) Orchards Development
7) Fruits & Berries Growing
8) Nurseries Development
9) Medicinal Plants and Aromatic Plants Growing
10) Water Abstraction works

Suggestive list of Non-Industrial Activities, which will not be allowed in 'No Development zone'.

1) Effluent Treatment Plant
2) Composting
3) Vermiculture
4) Animal stalls
5) Cattle & Goat Pens
6) Animal Husbandry
7) Fish Farming
8) Warehousing
9) Dumping of Ash, Waste, Solid Waste from City & Town

ANNEXURE-8

PTZ-330044/99 REGD. NO. D.L -33004/99

The Gazette of India

EXTRAORDINARY

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PART II – Section 3 - Sub-section (ii)

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MINISTRY OF ENVIRONMENT AND FORESTS
ORDER
New Delhi, the 29th May, 2001

S.O. 583 (E).- In exercise of the powers conferred by sub-sections (1) and (3) of section 3 of the Environment (Protection) Act, 1986 (29 of 1986) (hereinafter reference as the said Act), the Central Government hereby constitutes an authority to be known as "Water Quality Assessment Authority" consisting of the following members for a period of this years with effect from the date of publication of this notification is the Official Gazette, namely

1. Secretary, Ministry of Environment and Forests	-Chairperson
2. Additional Secretary and Project Director, National River Conservation Directorate, Ministry of Environment and forests	-Member
3. Chairman, Central Water Commission	-Member
4. Additional Secretary, Ministry of Water Resources	-Member
5. Adviser, National River Conservation Directorate, Ministry of Environment and Forests	-Member
6. Joint Secretary, Ministry of Agriculture and Cooperation	-Member
7. Joust Secretary, Ministry of Urban Affairs and Poverty Alleviation	-Member
8. Chairman, Central Ground Water Authority	-Member
9. Chairman, Central Pollution Control Board	-Member
10. Director, Indian Agricultural Research Institute, New Delhi	-Member
11. Director, National Environmental Engineering Research Institute. Nagpur	-Member
12. Commissioner (Water Management). Ministry of Water Resources	-Member Secretary

2. The Authority shall exercise the powers and functions:-

I. to exercise powers under section 5 of the said Act for issuing directions and for taking measures with respect to matters referred to in clauses (ix), (xi), (xii) and (xiii) of sub-section 2 of section 3 of the Act:

II. to direct the agencies (government/local bodies/non-governmental) for the following:

(a) to standardize method(s) for water quality monitoring and to ensure quality of data generation for utilization thereof;

(b) to take measures so as to ensure proper treatment of wastewater with a view to restoring the water quality of the river/water bodies to meet the designated-best-uses;

(c) to take up research and development activities in the area of water quality management;

(d) to promote recycling/re-use of treated sewage/trade effluent for irrigation in development of agriculture;

(e) to draw action plans for quality improvement in water bodies, and monitor and review/assess implementation of the schemes launched/to be launched to that effect;

(f) to draw scheme(s) for imposition of restriction in water abstraction and discharge of treated Sewage/trade effluent on land, rivers and other water bodies with a view to mitigating crisis of water quality

(g) to maintain minimum discharge for sustenance of aquatic life forms in river system;

(h) to promote rain water harvesting;

(i) to utilize self-assimilation capacities at the critical river stretches to minimize cost of effluent treatment;

(j) to provide information to pollution control authorities to facilitate allocation of waste load;

(k) to review the status of quality of national water resources (both surface water & groundwater) and identify 'Hot Spots" for taking necessary actions for improvement in water quality;

(l) to interact with the authorities/committees constituted or to be constituted under the provisions of the said Act for matters relating to management of water resources;

(m) to constitute/set-up State-level Water Quality Review Committees (WQRC) to coordinate the work to be assigned to such committees; and

(n) to deal with any environmental issue concerning surface and groundwater quality which may be referred to it by the Central Government or the State Government relating to the respective areas, for maintenance and/or restoration of quality to sustain designated-best-use

3. The Authority shall exercise the powers under section 19 of the said Act.

4. This Author may appoint domain experts for facilitating the work assigned to it.

5. The Ministry of Water Resources shall create a cell to assist the Authority to carry out the assigned functions.

6. The Authority shall furnish report about its activity at least once in three months to the Ministry of Environment and Forests.

[F. No. J-15011/8/2000-NRCD]
M. GOKHALE, Addl Secy.

ANNEXURE-9

MINISTRY OF ENVIRONMENT AND FORESTS
NOTLFICATION

New Delhi, the 17 June, 2005

S. 0. 2l51.-WHEREAS the Water Quality Assessment Authority (WQAA) was constituted by the Central Government vide Order No. S.O. 583 (E) dated the 29th May. 2001 and No. S.O. 635(E) dated the 27 October, 2004 to exercise powers under section 5 of the Environment (Protection) Act, 1986 (29 of 1986) for issuing directions and for taking measures with respect to matters referred to in clauses (ix),(xi), (xii) and (xiii) of sub-section(2) of section 3 of the said Act and to standardise method(s) for water quality monitoring and to ensure quality of data generation for utilization thereof and certain other purposes;

AND WHEREAS it is necessary and expedient to evolve water quality assessment and monitoring protocol as directed by the Water Quality Assessment Authority in order to maintain uniformity in the procedure for water quality monitoring mechanism by all monitoring agencies, departments, Pollution Control Boards and such other agencies so that water related action plans may be drawn up on the basis of reliable data;

AND WHEREAS the uniform process on water quality monitoring shall provide frequency of monitoring, procedure for sampling, parameters for analysis, analytical techniques, quality assurance and quality control system, infrastructure requirement for laboratories, procedure for data processing, reporting and dissemination and such other matters as the Central Government deems necessary for the said purpose, both for surface and ground water;

AND WHEREAS due to the deterioration of the river water quality, health and livelihood of the downstream people are being severely affected and concerns are raised time and again;

AND WHEREAS the immediate maintenance and restoration of wholesomeness' of the river water quality is the mandate under the Water (Prevention and Control of Pollution) Act 974 (6 of 1974) and that of maintenance of the ground water quality by the Central Ground Water Authority constituted under the provisions of the Environment (Protection) Act, 1986;

AND WHEREAS sub-rule(4) of rule 5 of the Environment (Protection) Rules, 1986, provides that whenever it appears to the Central Government that it is in public interest to do so, it. nay dispense with the requirement of notice under clause(a) of sub-rule(3) of the said rules";

AND WHEREAS the Central Government is of the opinion that it is in public interest to dispense with the requirement of notice under clause (a) of sub-rule(3) of rule 5 of the said rules to issue the Order.

NOW, THEREFORE. in exercise of the powers conferred by section 3 of the Environment (Protection) Act. 1986, the Central Government hereby makes the following order namely:-

1. Short title and commencement.

(a) This order may be called the Uniform Protocol on Water Quality Monitoring Order, 2005.

(b) It shall come into force on the date of its publication in the Official Gazette.

2. Application- It shall apply to all organizations, agencies and any other body monitoring surface and ground water quality for observance of uniform protocol on water quality monitoring.

3. Definitions-

In this Order, unless the context otherwise requires,-

(1) "agencies" means water quality monitoring agencies(government or non-government, local bodies) and other organizations including research and academic institutions involved in water quality monitoring of surface and ground waters;

(2) 'Authority" means the Water Quality Assessment Authority (WQAA) constituted under sub-sections (1) and (2) of section 3 of the Environment (Protection) Act) 1986;

(3) "Baseline stations" means the monitoring location where there is no influence of human activities on water quality;

(4) "Flux stations or Impact stations" means the location for measuring the mass of particular pollutant on main river stem for measuring the extent of pollution due to human interference or geological feature at any point of time and is necessary for measuring impact of pollution control measures adopted;

(5) "monitoring" means standardised measurement of identified parameters in order to define status and trends of water quality;

(6) "protocol" means a system of uniform water quality monitoring mechanism developed by the Water Quality Assessment Authority constituted under sub-sections (1) and (3) of section 3 of the Environment (Protection) Act, 1986;

(7)"Quality Assurance Programme" means a programme described in paragraph 12 of this Order.

(8) "Trend station" means the monitoring location designed to show how a particular point on a watercourse varies over time due, normally, to the influence of man's activities;

(9) "water quality monitoring network" means a systematic planning for collection, preservation and transportation, storage, analysis of water samples and dissemination of data fm national water bodies restricted to surface and ground water in the country.

4. Monitoring station and frequency of sampling:-

1) The frequency of sampling in respect of surface water shall be as follows :-

(a) All the stations shall be a combination of Baseline, Trend and Flux or Impact stations

(b) The Baseline stations shall be monitored four times a year for perennial rivers and lakes and three to four limes a year for seasonal rivers. Trend stations shall be monitored with an increased frequency of once in a month i.e. twelve times in a year. Flux or impact stations shall be monitored twelve to twenty-four times in a year depending upon pollution potential or importance of water use.

(c) All agencies shall follow the sampling frequency and parameters for analysis of surface water as mentioned in the Table-I given below:

Table-I
Frequencies and parameters for analysis of surface water samples

Type of Station	Frequency	Parameters
1	2	3
Baseline	Perennial rivers and Lakes Four times a year (seasonal) Seasonal rivers: 3-4 times (at equal spacing) during flow period.	(A) Pre-monsoon. Once Year. Analyse 25 parameters as listed below: (a) General – colour, odour, temperature, pH, Electrical conductivity (EC), Dissolved Oxygen (DO), Turbidity, Total dissolved solid (TDS) (b) Nutrients Ammoniacal Nitrogen (NH_4.N), Nutrite & Nitrite Nitrogen (NO_2+NO_3) Total Phosphate (Total P) (c) Demand parameters: Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD) (d) Major ions : Sodium (Na), potassium (K), Calcium (Ca), Magnesium (Mg), Bicarbonate (HCO_3) ,

	4 times a year (seasonal)	Carbonate (CO_3) ,chloride (Cl) , Sulphate (SO_4) (e) Other inorganic: Fluoride (F), Boron (B) and other location specific parameter, if any (f) Microbiological :Total Coliform and Faecal Coliform (B) Rest of the year (after the pre-monsoon sampling) at every three months interval. Analyse 10 parameters: Colour, Odour, Temperature, pH, EC, DO,NO_3+NO_2, BOD ,Total coliform and Faecal Coliform.
Trend or Impact or flux	Once every mounth starting April-May (pre-monsoon), i.e. 12 times a year.	(A) Pre-monsoon: Analyse 25 parameters as listed for baseline monitoring (B) Other months: Analyse 15 parameters as listed below. (a) General : Colour, Odour ,Temp, pH, EC, DO and Turbidity. (b) Nutrients: NH_3-N ,NO_2 + NO_3 ,Total P (c) Organic Matter : BOD, COD (d) Major ions : Cl (e) Microbiological : Total and Faecal Coliform (C) Micro pollutant : Once in a year pre monsoon. (i) Pesticides:Alpha Benzenehex chloride (BHC), Beta BHC, Gama BHC (linden), OP-Dichlorodiphenyltnchloroethane (OP-DDT), PP-DDT, Alpha Endosulphan, Beta Endosulphan, Aldrin, Dieldon, Carbaryl (Carbaniate), Malathian, Methyl Parathian, Anilophos, Chloropyriphos, (ii)Toxic Metals : Arsenic (AS), Cadmium (CD), Mercury (Hg), Zine (Zn), Chromium (Cr), Lead (Pb), Nickel (Ni), Iron (Fe) (The parameters may be selected based on local need).

Note: (i) The parameters mentioned in the above Table shall be the minimal requirement. .This does not, however, restrict analysis of more parameters depending upon the specific requirements of the analysing agency and its manpower availability.

(ii) For lakes or reservoirs, monitoring of additional parameters, like total Kjeldhal Nitrogen,

Chlorophyll, total Plankton count and productivity, shall be included in the list of parameters.

(iii) If biomonitoring is done in river or lakes or reservoirs additional specific parameters are to be considered.

(2) Ground Water

The frequency of sampling in respect of ground water shall be as follows:

(a) all stations shall he classified as Baseline stations.

(b) 20-25%of Baseline stations shall be classified as Trend stations where there is a perceived problem

(c) all agencies shall following the sampling frequency and parameters for analysis of ground water as mentioned in the Table-2 given below:-

Table -2
Frequencies and parameters for analysis of Ground Water samples

Type of Station	Frequency	Parameters
1	2	3
Baseline	Twice a year (Pre and Post Monsoon season)	(A) Pre and Post Monsoon Season Analyse 20 parameters as listed below. (a) General : Colour, odour, temperature, pH. EC, TDS (b) Nutrients: NO_2 + NO_3, orthophosphate (c) Demand Parameter: COD (d) Major Ions :Na_2 +, K+, Ca++,Mg++, CO3, HCO_3, CT, SO_4 %Na & SAR (e) Other inorganics: F, B and other location specific parameter if any.
Trend	Twice a year (pre and post monsoon)	(A) April – May: Analyse 20 parameters as listed for Baseline monitoring. (B) Other times: Analyse 14 parameters as listed below (1) General Colour, odour, temp, EC, pH, TDS, % Na & SAR (a) Nutrients: NO_2-NO_3, Orthophosphate (b) Demand parameter :COD (c) Major ions: Cl (d) Other inorganics: F,B (e) Microbiological: Total conform and faecal coliform (C) Micro pollutant: (parameters may be selected

		based on local need) (2) Pesticides - Alpha BHC, Beta, BHC, Gama, BHC (Lindane), OP-DDT, PP-DDT, Alpha Endosulphan, Beta Edosulpham, Aldrin, Dieldrin,. 2, 4-D, Carbaryl (Carbamate), Malathian, Methyl, Parathian, Anilphos, Choropyriphos (3) Toxic Metals-As, Cd, Hg. Zn. Cr. Pb, Ni, Fe (Pesticides and Toxic metals may be analaysed once a year in pre monsoon on selected locations).

Note:- (i) The parameters mentioned in the above Table shall be the minimal requirement. This does not, however, restrict analysis of more parameters depending upon the specific requirements of the analysing agency and its manpower availability.

(ii) If Chemical Oxygen Demand (COD) value exceeds 20 mg/l, the sample shall be analysed For Biochemical Oxygen Demand (BOD) also.

5. Sample Collection.

(1) The procedure for sample collection in respect of surface water shall be as under:

(a) Samples For Baseline and Trend stations shall be collected from well-mixed section of the river or main stern 30 cm below the water surface using a Dissolved Oxygen (DO) sampler or weighted bottle.

(b) Samples for Impact stations shall be collected from the point of interest, such as bathing ghat, down stream of point discharge, water supply intakes and other sources.

(c) The Dissolved Oxygen (DO) in the sample shall be fixed immediately after collection and Dissolved Oxygen (DO) analysis shall be done either in the field or in laboratory.

(2) The procedure for sample collection in respect of ground water shall be as under:

(a) Open dug wells, which are not in use or have been abandoned, shall not be considered as water quality monitoring station. However, such well could be considered for water level monitoring.

(b) Weighted sample bottle to collect sample from an open well about 30 cm below the surface of water may be used. The plastic bucket, which is likely to skim the surface layer only, shall not be used.

(c) Sample from the production tube well shall be collected alter running the well about five minute.

(d) Non-production piezometers shall be purged using a submersible pump. The purged water volume shall equal 4 to 5 times the standing water volume, before sample is collected.

(e) For bacteriological samples, when collected from tube wells or hand pump, the spout or outlet of the pump shall be sterilized under flame by spirit lamp before collection of sample in container.

6. Sample preservation and transportation.

(1) The type of containers and sample preservation to be adopted shall be as mentioned in the Table-3 below:

Table-3

1	2	3
Analysis	Container	Preservation
General	Glass, PE	4°C, dark
BOD	Glass, PE	4°C, dark
COD,NI-{3N02,N03	Glass,PE	H2S04,PH<2
Coliform	Glass, PE, Sterilised	4°C, dark
DO	BOO bottle	DO fixing chemicals
Fluoride	PE	None
P	Glass	None
Pesticides	Glass. Teflon	4°C, dark
Toxic metals	Glass, PE	HNO3, PH<2

(2) Samples shall be transported to concerned laboratory as soon as possible, preferably within forty-eight hours of collection.

(3) Analysis for coliform shall be started within twenty-four hours of collection of sample. If time is exceeded, it should be recorded with the result.

(4) Samples containing microgram/ I metal should be stored at 4°C aid analyzed as soon as possible. If the concentration is of mg/I level, it can be stored for up to 6 months, except mercury, for which the limit is 5 weeks.

(5) Sample Identification for the water sample analysis for surface and ground water samples shall be as mentioned in the Form-I and Form-Il.

7. Sample records.

(1) Each laboratory shall have a bound register, which shall be used for registering samples as they are received. A format for sample receipt register is annexed as **Form III.**

(2) The Laboratory incharge shall maintain a register for assignment of work to specific analyst.

8. Analytical techniques.

Each agency shall follow the analytical techniques prescribed in the Standard methods for Analysis of Water and Waste water published by American Public Health Association (Latest Edition) or Bureau of Indian Standards (BJS) Methods for Testing

Water and Wastewater-rnethods of sampling and testing (physical and chemical)
(IS:3025)

9. Analysis records and data validation.

A recommended format for recording data including all parameters except toxic metals and trace organics is enclosed as **Form - IV**. Report of heavy metals and trace organics as per Table 2 may be recorded separately. Validation checks should be performed in the laboratory on completion of the analysis. The results of laboratory analyses shall be entered in the format provided in **Form II** for validation.

10. Manpower requirements in laboratories.

The manpower requirements shall be optimised by the concerned monitoring agencies m order to get the maximum utilization of mandays, for timely completion analysis.

11. Data Processing, Reporting and Dissemination.

Each monitoring agency shall process the analytical data and report the data after validation to the Data Centre at the Central Pollution Control Board. The Central Pollution Control Board shall store the data and disseminate through website or electronic mail to various users on demand.

12. Quality Assurance and Accreditation of Laboratories.

The Quality Assurance Programme for the laboratories of various agencies shall contain a set of operating principles, written down and agreed upon by the organization, delineating specific functions and responsibilities of each person involved. Each laboratory of water quality monitoring agencies shall follow the guidelines or Quality Assurance Programme prescribed by their respective Central Laboratory or Headquarters and shall participate in Inter Laboratory Quality Assurance Programme like Proficiency Testing (PT) organized by them or any other agency on regular basis.

The Water Quality Laboratories shall seek recognition from the Ministry of Environment and Forests, Government of India or accreditation from National Accreditation Board for Testing and Calibration Laboratories (NABL) under the Ministry of Science and Technology, Government of India.

[F.No. 15011/B/2004-NRCD]
M. SENGUPTA, Adviser

FORM-I

Sample identification for surface water samples analysis and record.

Sample code											
Observer				Agency				Project			
Date Time	Station code										
Parameter Code	Container				Preservation				Treatment		
	GLASS	PVC	PE	TEFLON	NONE	COOL	ACID	OTHER	NONE	DECANT	FILTER
1)General											
2) Bacteriology											
3)BOD											
4) COD, NH, N03											
5) Toxic Metals											
6) Trace Organics											

Source of Sample				
Water	Point	Approach	Medium	Matrix
River	Main current	Bridge	Water	Fresh
Drain	Right Bank	Boat	Suspended matter	Brackish
Reservoir (lakes/tank/pond)	Left Bank	Wading	Biota	Salt
			Sediment	Effluent
Sample Type	Grab Time-comp Flow-comp Depth integ Width integ			
Sample Device	Weighted bottle pump Depth sampler			

Field Determinations			
Temp 0C	PH	EC Micromhos/cm	DO Mg/1
Odour Code	1) Odour Free 2) Rotten Eggs 3) Burnt Sugar 4) Soapy 5) Fishy 6) Septic 7) Aromatic 8) Chlorinous 9) Alcoholic 10) Unpleasant	Colour Code	1) light Brown 2)Brown 3) Dark Brown 4) Light Green 5) Green 6) Dark Green 7) Clear 8) Other (Specify)

Remarks	
Weather	Sunny, Cloudy, Rainy, Windy
Water Vel. M/s	High(,0.5) Medium (0.1-0.5) Low(,0.1) Standing
Water use	None, Cultivation Bathing, Washing, Cattle Washing Melon/vegetable farming in riverbed, Organised Water Supply

FORM-Il

Sample Identification for ground water samples.

Sample code											
Observer				Agency				Project			
Date	Time			Station code							
Source of sample Open dug well, Hand pump, Tube well, Prezometer											
Parameter Code	Container				Preservation				Treatment		
	Glass	PVC	PE	Teflon	None	Cool	Acid	Other	None	Decanl	Filter
1)General											
2) Bacteriology											
3)BOD											
4) COD,NH,N03											
5) Toxic Metals											
6) Trace Organics											

Field Determinations			
Temp ^{0}c	PH	EC micromho /cm	DO Mg/1
Odour Code	(1) Odour tree (6) Septic (2) Rotten eggs (7) Aromatic (3) Burnt sugar (8) Chlormous (4) Soapy (9) Alcoholic (5) Fishy (10) Unpleasant	Colour Code	(1) Light brown (2) Dark green (2) Brown (4) Clear (3) Dark brown (5) Green (4) Light green (7) Other(specify) (5) Green

IF WELL IS PURGED, COMPLETE BELOW			
Office well Data			
Diameter	Q		Cm
Depth	D		M
Static Water level (Avg)	SWL		M
Water Column(D-SWL)	H		M
Initial Volume Well	V		L
Projected Pump Discharge	PQ		L/s
Projected time of Purging (WPO)	PT		Min
Field Flow Measurement			
Static Water level on arrival	SWL		M
Actual Pump Setting			M
Purging duration			Min
Pump Discharge before sampling	Q		L/min
Pump Discharge after sampling	Q		L/min
Volume purged	V		L
Dynamic Water level	DWL		M
Field Chemical Measurement			
Time at start of sampling Started	T(0c)	EC (Micromho/cm)	Ph
+ 10 mm			
+ 20 mm			
+ 30 mm			
+ 40 mm			

FORM III

Sample Record for Analysis

Date time received at lab	Date time Collected	Station Code	Project	Collecting agency/ Collector	Preservation	Parameter code	Lab sample No.
1	2	3	4	5	6	7	8

Sample receipt register

Note:-

Column 3 gives the station code conventionally followed by the monitoring agency.

Column (4) gives the project under which the sample is collected.

Column (7) corresponds to the parameter(s) code given in the sample identification form.

Column (8) gives the laboratory sample assigned to the sample as it is received in the laboratory. Note that the numbering has two parts separated by a hyphen. The first part is assigned in a sequential manner as samples are received from various stations. If two samples are collected at the same time from a station for different sets of analysis, the first part of the number is the same. The second part corresponds to the parameter code as given in the sample.

The results of the analyses of all the samples having the same first part of the code would be entered in the data entry system as one sample having the same station code and same station code and time of sample collection

FORM –IV

Data Record Laboratory/organization Laboratory code

		Date of collection	Field determination					
			pH	EC micromotis/cm	DO mg/1	Temp.0C	Colour code	Odour code
1	2	3.	4.	5.	6.	7.	8.	9.

General				Nutrients			Org Matter	
pH	EC umho/cm	TDS, mg/1	TSS/mg/1	NH_2 mg	NO_2 NO_3 mg N/1	Total mg/1	BOD, mg/1	COD mg/1
10.	11.	12.	13.	14.	15.	16.	17.	18.

Alkalinity		Hardness		Major Icons							
Phen mg C co2/1	Total mg C co2/1	Total mg C co2/1	C++ mg C Co2/1	Ca mg/1	Mg, mg/1	Na mg/l	K mg/1	Cr mg/1	So 4 mg/l	CO3 mg/1	HC O3 mg/ 1
19.	20.	21.	22.	23	24	25.	26.	27	28	29	30

Other inorganics		Coliforms			Bio
Sir mg/1	F mg/1	B mg/1	Total MPN/100 ml	Faecal MPN/100ml	Chlorophyli A mg/1
31.	32.	33.	34.	35.	36.

Data Validation

Lab sample	Station code	Cations					Anions					
		Ca meq/1	Mg meq/1	Na meq/1	K meq/1	Meq/ total cations	C1 meq/1	So3 meq/1	Co2 meq/1	HCO meq/1	No2 NO3 meq/1	Total anions meq/1
3	3	39	40	4	42	43.	4	45	46.	47.	48.	49

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Ion Balance		TDS/EC Ratio	BOD/ COD Ratio	PH2 Vs Alkanity Ratio	CO3 bal	Verification Criteria	Checked by	Remark
(41)-(47)(41)+(47)	(39)/(42)	(12/(11)	(17/(18)	If(10)<8.3, is (19)=o?				
50.	51.	52.	53.	54.	55	56.	57.	58.

Government of India

Ministry of Water Resources

NATIONAL WATER POLICY

New Delhi
April, 2002

NATIONAL WATER POLICY- 2002

Need for a National Water Policy

1.1 Water is a prime natural resource, a basic human need and a precious national asset. Planning, development and management of water resources need to be governed by national perspectives.

1.2 As per the latest assessment (1993), out of the total precipitation, including snowfall, of around4000 billion cubic meter in the country, the availability from surface water and replenishable ground water is put at 1869 billion cubic meter. Because of topographical and other constraints, about 60% of this i.e. 690 billion cubic meter from surface water and 432 billion cubic meter from ground water, can be put to beneficial use. Availability of water is highly uneven in both space and time. Precipitation is confined to only about three or four months in a year and varies from 100 mm in the western parts of Rajasthan to over 10000 mm at Cherrapunji in Meghalaya. Rivers and under ground aquifers often cut across state boundaries. Water, as a resource is one and indivisible: rainfall, river waters, surface ponds and lakes and ground water are all part of one system.

1.3 Water is part of a larger ecological system. Realising the importance and scarcity attached to the fresh water, it has to be treated as an essential environment for sustaining all life forms.

1.4 Water is a scarce and precious national resource to be planned, developed, conserved and managedas such, and on an integrated and environmentally sound basis, keeping in view the socio-economic aspects and needs of the States. It is one of the most crucial elements in developmental planning. As the country has entered the 21st century, efforts to develop, conserve, utilise and manage this important resource in a sustainable manner, have to be guided by the national perspective.

1.5 Floods and droughts affect vast areas of the country, transcending state boundaries. One-sixth area of the country is drought-prone. Out of 40 million hectare of the flood prone area in the country, on an average, floods affect an area of around 7.5 million hectare per year. Approach to management of droughts and flood has to be co-ordinated and guided at the national level.

1.6 Planning and implementation of water resources projects involve a number of socio-economic aspects and issues such as environmental sustainability, appropriate resettlement and rehabilitation of project-affected people and livestock, public health concerns of water impoundment, dam safety etc. Common approaches and guidelines are necessary on these matters. Moreover, certain problems and weaknesses have affected a large number of water resources projects all over the country. There have been substantial time and cost overruns on projects. Problems of water logging and soil salinity have

emerged in some irrigation commands, leading to the degradation of agricultural land. Complex issues of equity and social justice in regard to water distribution are required to be addressed. The development, and overexploitation of groundwater resources in certain parts of the country have raised the concern and need for judicious and scientific resource management and conservation. All these concerns need to be addressed on the basis of common policies and strategies.

1.7 Growth process and the expansion of economic activities inevitably lead to increasing demands for water for diverse purposes: domestic, industrial, agricultural, hydro-power, thermal-power, navigation, recreation, etc. So far, the major consumptive use of water has been for irrigation. While the gross irrigation potential is estimated to have increased from 19.5 million hectare at the time of independence to about 95 million hectare by the end of the Year 1999-2000, further development of a substantial order is necessary if the food and fiber needs of our growing population are to be met with. The country's population which is over 1027 million (2001 AD) at present is expected to reach a level of around 1390 million by 2025 AD.

1.8 Production of food grains has increased from around 50 million tones in the fifties to about 208 million tones in the Year 1999-2000. This will have to be raised to around 350 million tones by the year 2025 AD. The drinking water needs of people and livestock have also to be met. Domestic and industrial water needs have largely been concentrated in or near major cities. However, the demand in rural areas is expected to increase sharply as the development programmes improve economic conditions of the rural masses. Demand for water for hydro and thermal power generation and for other industrial uses is also increasing substantially. As a result, water, which is already a scarce resource, will become even scarcer in future. This underscores the need for the utmost efficiency in water utilisation and a public awareness of the importance of its conservation.

1.9 Another important aspect is water quality. Improvements in existing strategies, innovation of new techniques resting on a strong science and technology base are needed to eliminate the pollution of surface and ground water resources, to improve water quality. Science and technology and training have to play important roles in water resources development and management in general.

1.10 National Water Policy was adopted in September, 1987. Since then, a number of issues and challenges have emerged in the development and management of the water resources. Therefore, the National Water Policy (1987) has been reviewed and updated.

Information System

2.1 A well developed information system, for water related data in its entirety, at the national / state level, is a prime requisite for resource planning. A standardised national information system should be stablished with a network of data banks and data bases, integrating and strengthening the existing Central and State level agencies and improving the quality of data and the processing capabilities.

2.2 Standards for coding, classification, processing of data and methods / procedures for its collection should be adopted. Advances in information technology must be introduced to create a modern information system promoting free exchange of data among various agencies. Special efforts should be made to develop and continuously upgrade technological capability to collect, process and disseminate reliable data in the desired time frame.

2.3 Apart from the data regarding water availability and actual water use, the system should also include comprehensive and reliable projections of future demands of water for diverse purposes.

Water Resources Planning

3.1 Water resources available to the country should be brought within the category of utilizable resources to the maximum possible extent.

3.2 Non-conventional methods for utilisation of water such as through inter-basin transfers, artificial recharge of ground water and desalination of brackish or sea water as well as traditional water conservation practices like rainwater harvesting, including roof-top rainwater harvesting, need to be practiced to further increase the utilisable water resources. Promotion of frontier research and development, in a focused manner, for these techniques is necessary.

3.3 Water resources development and management will have to be planned for a hydrological unit such as drainage basin as a whole or for a sub-basin, multi-sectorally, taking into account surface and ground water for sustainable use incorporating quantity and quality aspects as well as environmental considerations. All individual developmental projects and proposals should be formulated and considered within the framework of such an overall plan keeping in view the existing agreements / awards for a basin or a sub basin so that the best possible combination of options can be selected and sustained.

3.4 Watershed management through extensive soil conservation, catchment-area treatment, preservation of forests and increasing the forest cover and the construction of check-dams should be promoted. Efforts shall be to conserve the water in the catchment.

3.5 Water should be made available to water short areas by transfer from other areas including transfers from one river basin to another, based on a national perspective, after taking into account the requirements of the areas / basins.

Institutional Mechanism

4.1 With a view to give effect to the planning, development and management of the water resources on a hydrological unit basis, along with a multi-sectoral, multi-disciplinary and participatory approach as well as integrating quality, quantity and the environmental aspects, the existing institutions at various levels under the water resources sector will have to be appropriately reoriented / reorganised and even created, wherever necessary. As maintenance of water resource schemes is under non-plan budget, it is generally being neglected. The institutional arrangements should be such that this vital aspect is given importance equal or even more than that of new constructions.

4.2 Appropriate river basin organisations should be established for the planned development and management of a river basin as a whole or sub-basins, wherever necessary. Special multi-disciplinary units should be set up to prepare comprehensive plans taking into account not only the needs of irrigation but also harmonising various other water uses, so that the available water resources are determined and put to optimum use having regard to existing agreements or awards of Tribunals under the relevant laws. The scope and powers of the river basin organisations shall be decided by the basin states themselves.

Water Allocation Priorities

5. In the planning and operation of systems, water allocation priorities should be broadly as follows:

- Drinking water
- Irrigation
- Hydro-power
- Ecology
- Agro-industries and non-agricultural industries
- Navigation and other uses.

However, the priorities could be modified or added if warranted by the area / region specific considerations.

Project Planning

6.1 Water resource development projects should as far as possible be planned and developed as multipurpose projects. Provision for drinking water should be a primary consideration.

6.2 The study of the likely impact of a project during construction and later on human lives, settlements,

occupations, socio-economic, environment and other aspects shall form an essential component of project planning.

6.3 In the planning, implementation and operation of a project, the preservation of the quality of environment and the ecological balance should be a primary consideration. The adverse impact on the environment, if any, should be minimised and should be offset by adequate compensatory measures. The project should, nevertheless, be sustainable.

6.4 There should be an integrated and multi-disciplinary approach to the planning, formulation, clearance and implementation of projects, including catchment area treatment and management, environmental and ecological aspects, the rehabilitation of affected people and command area development. The planning of projects in hilly areas should take into account the need to provide assured drinking water, possibilities of hydro-power development and the proper approach to irrigation in such areas, in the context of physical features and constraints of the basin such as steep slopes, rapid run-off and the incidence of soil erosion. The economic evaluation of projects in such areas should also take these factors into account.

6.5 Special efforts should be made to investigate and formulate projects either in, or for the benefit of, areas inhabited by tribal or other specially disadvantaged groups such as socially weak, scheduled castes and scheduled tribes. In other areas also, project planning should pay special attention to the needs of scheduled castes and scheduled tribes and other weaker sections of the society. The economic evaluation of projects benefiting such disadvantaged sections should also take these factors into account.

6.6 The drainage system should form an integral part of any irrigation project right from the planning stage.

6.7 Time and cost overruns and deficient realisation of benefits characterising most water related projects should be overcome by upgrading the quality of project preparation and management. The inadequate funding of projects should be obviated by an optimal allocation of resources on the basis of prioritisation, having regard to the early completion of on-going projects as well as the need to reduce regional imbalances.

6.8 The involvement and participation of beneficiaries and other stakeholders should be encouraged right from the project planning stage itself.

Ground Water Development

7.1 There should be a periodical reassessment of the ground water potential on a scientific basis, taking into consideration the qualit y of the water available and economic viability of its extraction.

7.2 Exploitation of ground water resources should be so regulated as not to exceed the recharging possibilities, as also to ensure social equity. The detrimental environmental consequences of overexploitation of ground water need to be effectively prevented by the Central and State Governments. Ground water recharge projects should be developed and implemented for improving both the quality and availability of ground water resource.

7.3 Integrated and coordinated development of surface water and ground water resources and their conjunctive use, should be envisaged right from the project planning stage and should form an integral part of the project implementation.

7.4 Over exploitation of ground water should be avoided especially near the coast to prevent ingress of seawater into sweet water aquifers.

Drinking Water

8. Adequate safe drinking water facilities should be provided to the entire population both in urban and in rural areas. Irrigation and multipurpose projects should invariably include a drinking water component, wherever there is no alternative source of drinking water. Drinking water needs of human beings and animals should be the first charge on any available water.

Irrigation

9.1 Irrigation planning either in an individual project or in a basin as a whole should take into account the irrigability of land, cost-effective irrigation options possible from all available sources of water and appropriate irrigation techniques for optimising water use efficiency. Irrigation intensity should be such as to extend the benefits of irrigation to as large a number of farm families as possible, keeping in view the need to maximise production.

9.2 There should be a close integration of water-use and land-use policies.

9.3 Water allocation in an irrigation system should be done with due regard to equity and social justice. Disparities in the availability of water between head-reach and tail-end farms and between large and small farms should be obviated by adoption of a rotational water distribution system and supply of water on a volumetric basis subject to certain ceilings and rational pricing.

9.4 Concerted efforts should be made to ensure that the irrigation potential created is fully utilised. For this purpose, the command area development approach should be adopted in all irrigation projects.

9.5 Irrigation being the largest consumer of fresh water, the aim should be to get optimal productivity per unit of water. Scientific water management, farm practices and sprinkler and drip system of irrigation should be adopted wherever feasible.

9.6 Reclamation of water logged / saline affected land by scientific and cost-effective methods should form a part of command area development programme.

Resettlement and Rehabilitation

10. Optimal use of water resources necessitates construction of storages and the consequent resettlement and rehabilitation of population. A skeletal national policy in this regard needs to be formulated so that the project affected persons share the benefits through proper rehabilitation. States should accordingly evolve their own detailed resettlement and rehabilitation policies for the sector, taking into account the local conditions. Careful planning is necessary to ensure that the construction and rehabilitation activities proceed simultaneously and smoothly.

Financial and Physical Sustainability

11. Besides creating additional water resources facilities for various uses, adequate emphasis needs to be given to the physical and financial sustainability of existing facilities. There is, therefore, a need to ensure that the water charges for various uses should be fixed in such a way that they cover at least the operation and maintenance charges of providing the service initially and a part of the capital costs subsequently. These rates should be linked directly to the quality of service provided. The subsidy on water rates to the disadvantaged and poorer sections of the society should be well targeted and transparent.

Participatory Approach to Water Resources Management

12. Management of the water resources for diverse uses should incorporate a participatory approach; by involving not only the various governmental agencies but also the users and other stakeholders, in an effective and decisive manner, in various aspects of planning, design, development and management of the water resources schemes. Necessary legal and institutional changes should be made at various levels for the purpose, duly ensuring appropriate role for women. Water Users' Associations and the local bodies such as municipalities and gram panchayats should particularly be involved in the operation, maintenance and management of water infrastructures / facilities at appropriate levels progressively, with a view to eventually transfer the management of such facilities to the user groups / local bodies.

Private Sector Participation

13. Private sector participation should be encouraged in planning, development and management of water resources projects for diverse uses, wherever feasible. Private sector participation may help in introducing innovative ideas, generating financial resources and introducing corporate management and improving service efficiency and accountability to users. Depending upon the specific situations, various combinations of private sector participation, in building, owning, operating, leasing and transferring of water resources facilities, may be considered.

Water Quality

14.1 Both surface water and ground water should be regularly monitored for quality. A phased programme should be undertaken for improvements in water quality.

14.2 Effluents should be treated to acceptable levels & standards before discharging them into natural streams.

14.3 Minimum flow should be ensured in the perennial streams for maintaining ecology and social considerations.

14.4 Principle of 'polluter pays' should be followed in management of polluted water.

14.5 Necessary legislation is to be made for preservation of existing water bodies by preventing encroachment and deterioration of water quality.

Water Zoning

15. Economic development and activities including agricultural, industrial and urban development, should be planned with due regard to the constraints imposed by the configuration of water availability. There should be a water zoning of the country and the economic activities should be guided and regulated in accordance with such zoning.

Conservation of Water

16.1 Efficiency of utilisation in all the diverse uses of water should be optimised and an awareness of water as a scarce resource should be fostered. Conservation consciousness should be promoted through education, regulation, incentives and disincentives.

16.2 The resources should be conserved and the availability augmented by maximising retention, eliminating pollution and minimising losses. For this, measures like selective linings in the conveyance

system, modernisation and rehabilitation of existing systems including tanks, recycling and re-use of treated effluents and adoption of traditional techniques like mulching or pitcher irrigation and new techniques like drip and sprinkler may be promoted, wherever feasible.

Flood Control and Management

17.1 There should be a master plan for flood control and management for each flood prone basin.

17.2 Adequate flood-cushion should be provided in water storage projects, wherever feasible, to facilitate better flood management. In highly flood prone areas, flood control should be given overriding consideration in reservoir regulation policy even at the cost of sacrificing some irrigation or power benefits.

17.3 While physical flood protection works like embankments and dykes will continue to be necessary, increased emphasis should be laid on non-structural measures such as flood forecasting and warning, flood plain zoning and flood proofing for the minimisation of losses and to reduce the recurring expenditure on flood relief.

17.4 There should be strict regulation of settlements and economic activity in the flood plain zones along with flood proofing, to minimise the loss of life and property on account of floods.

17.5 The flood forecasting activities should be modernised, value added and extended to other uncovered areas. Inflow forecasting to reservoirs should be instituted for their effective regulation.

Land Erosion by Sea or River

18.1 The erosion of land, whether by the sea in coastal areas or by river waters inland, should be minimised by suitable cost-effective measures. The States and Union Territories should also undertake all requisite steps to ensure that indiscriminate occupation and exploitation of coastal strips of land are discouraged and that the location of economic activities in areas adjacent to the sea is regulated.

18.2 Each coastal State should prepare a comprehensive coastal land management plan, keeping in view the environmental and ecological impacts, and regulate the developmental activities accordingly.

Drought-prone Area Development

19.1 Drought-prone areas should be made less vulnerable to drought-associated problems through soil

moisture conservation measures, water harvesting practices, minimisation of evaporation losses, development of the ground water potential including recharging and the transfer of surface water from surplus areas where feasible and appropriate. Pastures, forestry or other modes of development which are relatively less water demanding should be encouraged. In planning water resource development projects, the needs of drought-prone areas should be given priority.

19.2 Relief works undertaken for providing employment to drought-stricken population should preferably be for drought proofing.

Monitoring of Projects

20.1 A close monitoring of projects to identify bottlenecks and to adopt timely measures to obviate time and cost overrun should form part of project planning and execution.

20.2 There should be a system to monitor and evaluate the performance and socio-economic impact of the project.

Water Sharing / Distribution amongst the States

21.1 The water sharing / distribution amongst the states should be guided by a national perspective with due regard to water resources availability and needs within the river basin. Necessary guidelines, including for water short states even outside the basin, need to be evolved for facilitating future agreements amongst the basin states.

21.2 The Inter-State Water Disputes Act of 1956 may be suitably reviewed and amended for timely adjudication of water disputes referred to the Tribunal.

Performance Improvement

22. There is an urgent need of paradigm shift in the emphasis in the management of water resources sector. From the present emphasis on the creation and expansion of water resources infrastructures for diverse uses, there is now a need to give greater emphasis on the improvement of the performance of the existing water resources facilities. Therefore, allocation of funds under the water resources sector should be re-prioritised to ensure that the needs for development as well as operation and maintenance of the facilities are met.

Maintenance and Modernisation

23.1 Structures and systems created through massive investments should be properly maintained in good health. Appropriate annual provisions should be made for this purpose in the budgets.

23.2 There should be a regular monitoring of structures and systems and necessary rehabilitation and modernisation programmes should be undertaken.
23.3 Formation of Water Users' Association with authority and responsibility should be encouraged to facilitate the management including maintenance of irrigation system in a time bound manner.

Safety of Structures

24. There should be proper organisational arrangements at the national and state levels for ensuring the safety of storage dams and other water-related structures consisting of specialists in investigation, design, construction, hydrology, geology, etc. A dam safety legislation may be enacted to ensure proper inspection, maintenance and surveillance of existing dams and also to ensure proper planning, investigation, design and construction for safety of new dams. The Guidelines on the subject should be

periodically updated and reformulated. There should be a system of continuous surveillance and regular visits by experts.

Science and Technology

25. For effective and economical management of our water resources, the frontiers of knowledge need to be pushed forward in several directions by intensifying research efforts in various areas, including the following:

- hydrometeorology;
- snow and lake hydrology;
- surface and ground water hydrology;
- river morphology and hydraulics;
- assessment of water resources;
- water harvesting and ground water recharge;
- water quality;
- water conservation;
- evaporation and seepage losses;
- recycling and re-use;
- better water management practices and improvements in operational technology;
- crops and cropping systems;
- soils and material research;

- new construction materials and technology (with particular reference to roller compacted concrete, fiber reinforced concrete, new methodologies in tunneling technologies, instrumentation, advanced numerical analysis in structures and back analysis);
- seismology and seismic design of structures;
- the safety and longevity of water-related structures;
- economical designs for water resource projects;
- risk analysis and disaster management;
- use of remote sensing techniques in development and management;
- use of static ground water resource as a crisis management measure;
- sedimentation of reservoirs;
- use of sea water resources;
- prevention of salinity ingress;
- prevention of water logging and soil salinity;
- reclamation of water logged and saline lands;
- environmental impact;
- regional equity.

Training

26. A perspective plan for standardised training should be an integral part of water resource development. It should cover training in information systems, sectoral planning, project planning and formulation, project management, operation of projects and their physical structures and systems and the management of the water distribution systems. The training should extend to all the categories of personnel involved in these activities as also the farmers.

Conclusion

27. In view of the vital importance of water for human and animal life, for maintaining ecological balance and for economic and developmental activities of all kinds, and considering its increasing scarcity, the planning and management of this resource and its optimal, economical and equitable use has become a matter of the utmost urgency. Concerns of the community need to be taken into account for water resources development and management. The success of the National Water Policy will depend entirely on evolving and maintaining a national consensus and commitment to its underlying principles and objectives. To achieve the desired objectives, State Water Policy backed with an operational action plan shall be formulated in a time bound manner say in two years. National Water Policy may be revised periodically as and when need arises.

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