Guidelines for Water Quality Management

CENTRAL POLLUTION CONTROL BOARD
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FOREWORD

Water Quality Assessment Authority (WQAA) was constituted under Environment (Protection) Act, 1986, by the Central Government under the. Chairmanship of the Secretary, Ministry of Environment & Forests, vide Notification No. SO 583 (E) dated 29.5.2001, to standardize method for water quality monitoring and to ensure quality of data generated, including water quality management aspects. In May, 2005, the WQAA while reviewing the water quality monitoring program being carried out by different agencies, including CPCB, NRCD, CWC, CGWB, State Ground Water Departments and Irrigation or Water Resources Departments in different States of the country, decided that the data generated by these should be used for formulation of water quality management plan to help restoration of water quality. WQAA also decided that CPCB should prepare Guidelines for water quality management plan. In compliance to the decision, CPCB has prepared draft Guidelines which was extensively reviewed by Water Quality Monitoring Committee (WQMC) under WQAA and State Agencies. The final version of the Guidelines Document was approved by WQMC for implementation.

The Guidelines attempt to summarize, legal and policy matter related to water quality management, the step-wise activities required for formulation of action plan to restore water quality, the options that may be considered for action plan, the formats for inventory of polluting activities and various water conservation measures. I hope this Document will be useful to all concerned with water quality management.

(J.M. Mauskar)

1st January 2008

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1. Introduction

Water is most essential but scarce resource in our country. Presently the quality & the availability of the fresh water resources is the most pressing of the many environmental challenges on the national horizon. The stress on water resources is from multiple sources and the impacts can take diverse forms. Geometric increase in population coupled with rapid urbanization, industrialization and agricultural development has resulted in high impact on quality and quantity of water in our country. The situation warrants immediate redressal through radically improved water resource and water quality management strategies. The present document highlights the steps involved in preparation of a water quality management plan in a rational manner.

2. Step-I Setting Water Quality Goal

- For preparation of water quality management plan the first step is to identify water quality goal for the water body in question.
- To set the water goal one has to identify use(s) of water (please refer Annexure 1) in the given water body or its part in question.
- If the water body is used for more than one use than identify the use , which demands highest quality of water called "designated best use".
- Identify the water quality requirements for that "designated bast use" in terms of primary water quality criteria.

3. Step-II Water Quality Monitoring

- Water quality monitoring is to be carried to acquire the knowledge on existing water quality of the water body.
- Water Quality Assessment Authority has notified a "Protocol for Water Quality Monitoring" (Annexure 2) .
- This protocol should be followed to monitor the water quality.

4. Step-III Identification of Nature and Magnitude of Pollution

- After repeated observations on water quality covering different seasons, the water quality data should be compiled and compared with the desired quality requirement as per the water quality goal set in step-I. Using this exercise CPCB has identified polluted water bodies in the country (Annexure 3)
- This comparison would lead to identification of the gaps with respect one or more parameter(s) and also extent of gap, which will ultimately help in identification of nature and magnitude of pollution control needed.

5. Step-IV Source Inventory

- Once the nature and magnitude of pollution is identified, it is important that the source(s) of such pollution is/are identified.
- Inventorise the number of outfalls joining the water body for identification of point sources (Inventory form Annexure 4).
- Measure the quality and quantity of wastewater flowing through each of the outfalls.
- For each outfall pollution load joining per unit time (normally per day) should be measured in terms of important pollutants. This exercise requires continuous sampling for 24/48/72 hours on flow based composite basis.
- The pollution load joining through all the important outfalls should be measured.
- Inventorise the human activities in the upstream catchments area of the water body to identify the non-point sources of pollution. The activities could be open defication, unsewered sanitation, uncollected garbage sewage and industrial wastes, commercial wastes in case of urban or industrial areas and application of agrochemicals in case of rural areas.

6. Step – V Water Quantity information

- In case of river or stream acquire the flow data from CWC, State Irrigation Deptt. For atleast last 5 years or more.
- In case of lakes, reservoirs collect the information on water levels for atleast last 5 to 10 years
- Carry out mass balance to estimate the dilution available in different seasons.
- Estimate the least dilution available in last 5 years.
- Assess the assimilation capacity by applying simple streeter-phelps equation and generate different scenario to estimate the extent of pollution control required.

- This exercise would give precisely how much pollution load needs to be reduced to achieve the desired water quality.

7. Step – VI Selection of Technology

- Simpler technology should be adopted for sewage treatment.
- Treatment scheme based on series of Waste Stabilization Ponds (WSP) technology is quit rugged, one of the most economical ones and suitable for small towns where sufficient land is easily available. Multiple stage ponds (at least three) with first pond as anaerobic one is the most widely used and suitable configuration.
- Sewage collection and treatment being primary responsibility of local authorities.
- Many times sewage can be found flowing in open drains in most of the cities, as these do not have full sewerage.. Low strength sewage received from open drains is not ideal for anaerobic biological treatment as recovery of use full byproduct, biogas, is meager.
- Simpler option of treatment such as series of waste stabilization ponds may prove to be cost effective in such conditions.
- There is scope to reduce the cost of the material used for laying down the sewers.
- Use of low volume flushing tanks will help in reducing waste water volume and thereby cost of sewerage and sewage treatment.
- For low income housing colonies either two pit pour flush water seal latrines or a shallow sewer could a possible option.
- Co-operative group housing societies, multi storied housing complexes, big hotels etc. need to set up appropriate on-site waste water treatment facilities for recycling of waste water for gardening and other non-domestic uses to the extent feasible.
- Renovation of existing drainage system, which currently acts as open sewers, and dovetailing the renovated drainage system to appropriate forestry programme or tree plantation, will reduce sewage treatment cost.
- The options which are available for cost-effective and environmentally compatible sewage treatment include land treatment, waste stabilization ponds, constructed wetlands, duck-weed pond, aerated lagoon, rotating biological contractors, up-flow anaerobic sludge blanket system and root zone treatment.
- Top layer of soil under the vegetative cover maintains microenvironment within which soil flora and fauna decompose the organic matter. Thus, top layer of soil can be utilized for the treatment of domestic sewage and variety of biodegradable wastewaters (root-zone treatment). Land treatment can tolerate fluctuation in loading more readily than conventional processes. This technology is well established in U.S.A., Canada, Australia, and U.K. and also attempted in China and few other developing countries including India. The Central Pollution Control Board has evolved guidelines on application of this technology in Indian condition.
- The use of biotechnology could be another option for waste treatment under NRCD particularly with respect to organic pollution. Inorganic pollutants like nitrogen, and phosphorus can also be removed by this technology.

8. Step - VII Financing Waste Management

Effluent Tax

- Today there is no provision for collection and treatment of about 22000 mld of wastewater. With fast urbanization this quantity will be about 40,000 mld by the end of 11th Plan. Each mld cost about Rs. 1 crore for establishing treatment facilities and about 4 crores for collection facilities. This makes total requirement of funds in the tune of more than one lakh crores just for establishing facilities. The operation and maintenance may be another about 10% of the above cost every year. Funding of such schemes from exchequer's fund in order to achieve the goals, as is being done today under NRCP, would be detrimental to the economy of the country.
- The present approach of financing the waste management is neither adequate nor effective in tackling the massive problem water quality degradation. Thus the approach needs to be changed.
- The major part of the cost on waste management should be born by the urban population according to 'polluter pay principle'.
- It can be applied to any dischargers, cities or industries, with two benefits; it induces waste reduction and treatment and can provide a source of revenue for financing wastewater treatment investments.
- Municipal wastewater treatment is a particularly costly and long-term undertaking so that sound strategic planning and policies for treatment are of special importance.
- Pricing and demand management are important instruments for encouraging efficient domestic and industrial water-use practices and for reducing wastewater volumes and loads.
- Water and sewerage fees can induce urban organisations to adopt water-saving technologies, including water recycling and reuse systems, and to minimise or eliminate waste products that would otherwise

end up in the effluent stream.

- In addition to price based incentives, demand management programmes should include educational and technical components, such as water conservation campaigns, advice to consumers, and promotion, distribution or sale of water-saving devices like "six-litre" toilets which use less than half the volume of water per flush than a standard toilet.

Beneficiaries

It is also important to consider the beneficiaries. The waste management benefits following:

1. Local citizens
2. Protection of environment
3. Protection of Public health
4. Protection of water resources – water supply, irrigation, other uses
5. Protection of industrial use
6. Enhanced Property values
7. Enhanced tourism

All the above agencies may contribute to waste management. A mechanism can be evolved to coordinate with all the beneficiaries and charge them the benefit tax.

9. Step – VIII Maintenance of sewage treatment plants

- Operation and maintenance of the treatment plants, sewage pumping stations is a neglected field, as nearly 39% plants are not conforming to the general standards prescribed under the Environmental (Protection) Rules for discharge into streams as per the CPCB's survey report.
- STPs are usually run by personals that do not have adequate knowledge of running the STPs and know only operation of pumps and motors.
- The operational parameters are not regularly analyzed hence the day-to-day variation in performance is not evaluated at most of the STPs. Thus, there is a need that persons having adequate knowledge and trained to operate the STPs be engaged to manage STPs and an expert be engaged to visit the STPs at least once a month and advice for improvement of its performance.
- In a number of cities, the existing treatment capcity remains underutilized while a lot of sewage is discharged without treatment in the same city.
- Auxiliary power back-up facility is required at all the intermediate (IPS) & main pumping stations (MPS) of all the STPs. It is very essential that they be efficiently maintained by the local authoritis whose properties and charge they are.
- Inter-agency feuds and inadequate consideration of which agency would be responsible for what has led to inadequate maintenance of various STPs and other facilities created.
- The maintenance of the sewage system, namely, sewers, rising mains, intermediate pumping stations, etc. should also be entrusted to the nodal agencies identified for the maintenance of the sewage treatment plants and sufficient funds and staff provided to them.
- Facilities like community toilets, electric crematoria, etc. should be maintained by the local bodies. Also the aspect of resource recovery by way of raising the revenue through sale of treated effluent for irrigation, of sludge as a manure and biogas utilization for power generation wherever provision exist needs to be addressed. Biogas generation, pisciculture from sewage as envisaged in the Ganga Action Plan is still in the starting stages.

10. Step – IX Pollution from industrial sources

A. Pollution control at source

- The water polluting industries which had not so far installed ETPs should be asked to furnish a time bound programme to the Ministry of Environment and Forests for treatment of their effluents.
- Those who have given commitment under Corporate Responsibility on Environment Protection (CREP) should adhere to it.
- Such programmes should clearly indicate the existing and proposed arrangements with detailed time schedules. The programme should be backed up by a commitment from the Administrative Ministry concerned or the respective State Government, as the case may be, to provide the funds as necessary and ensure compliance by the industries.

- If the undertakings and the administrative Ministry/State Government failed to respond, action under the Environment (Protection) Act need to be taken forthwith thereafter.
- SPCBs should monitor the progress and report on the outcome. The SPCBs should examine the prevailing arrangements in charging water supply for industry and formulate proposals in consultation with the concerned

departments on how the system can be rationalized to conserve water and recycle it for use.

- Emerging technologies such as aerobic composting, vermiculture, ferti-irrigation, etc. as secondary treatment should be adopted for the organic wastes by the industries. Recently, the root-zone technology is also being advocated is yet another alternative for energy saving for treatment of industrial wastewaters.
- Incentives have to be made more attractive to make the industries undertake pollution control measures. It is important to assess the effectiveness of this measure and work out other measures which would serve as effective incentives for pollution control.

B. Reuse/recycling of treated industrial waste and resource recovery:

- The reuse and recycling of wastes for agricultural purpose would not only help to reduce the pollution and requirement of fresh water for such use but also would supplement the much needed nutrients and organic manure to the plants.

- The segregation of waste water streams may help in reducing waste water volume and waste strength and may help recycling and reuse of majority of waste streams. The quantity of the effluent generated in sugar industry can be reduced from 300 litres to 50 litres per tonne of cane crushed, if recycling techniques are meticulously followed. The wastewater quantity generated in continuous fermentation distilleries is 7 litres per litre of alcohol produced, as compared to 14-15 litres per litre of alcohol produced in batch fermentation process distilleries. The reduction in wastewater quantity is mainly achieved by recycling wash and adopting reboiler system. In pulp and paper industries, the paper mill wastewater is completely recycled into pulp mill by adopting fibre recovery system. It has helped to reduce the wastewater from 200 cum to 50 cum per tonne of paper produced.

C. Waste minimization and clean technologies:

- It may be noted that by recycling techniques the waste concentrations may increase, however the total load remain the same. The concentration of waste strength would help the economical conversion of spent wash to biofertilizer. Waste strength reduction can be achieved by adopting in plant control measures such as reduction of spillages of wastes, elimination of process failures, use of proper equipment for handling and dry cleaning techniques etc. This is often termed as clean technologies; it does not add to the cost of production, in fact industry gains from it.
- Innovation in pollution prevention/waste minimization efforts on the part of the industries needs to be sternly promoted. Pollution prevention/ waste minimization, in our country at least, is done only for product quality improvement, energy saving or other economic reasons and any reduction in pollution is only incidental.
- All organic wastes are best source of energy. A number of anaerobic technologies are now available for treatment of organic industrial effluents. Spent wash, black liquor (pulp mill), dairy effluents, sugar factory effluents and press mud etc. are some of the organic wastes tried for energy recovery. The energy recovery will incidentally solve the air pollution problem, as biogas is a cleaner fuel compared to baggasse, rice husk or coal. It is essential to introduce energy audit in all the industries so hat cost-benefit ratio can be established in each case.
- Bio-fertilizers are now prepared from organic rich wastes by admixing filler materials. Spent wash is converted to manure by addition of press mud, bagasse cillo, agricultural residues etc. In this technology the entire liquor effluent is converted into solid mass and it can be termed as "Zero-discharge" technology.

D. Waste water discharge standards and charges on residual pollution

- The limits need to be fixed on water use and wastewater generation per unit production for each industry. In order to achieve this goal, guidelines are to be evolved and the industry should be forced to adopt recycling and reuse through legislation and vigilance monitoring.
- New measures such as imposing charges on residual pollution once the prescribed limits are complied will have to be introduced to encourage recycle and reuse of effluents and adoption of the zero-discharge concept.

E. Mixing sewage with industrial waste wherever advantageous

- Wherever it is possible, industrial wastes should be combined with domestic wastes for treatment if no toxicity.
- Economy of scale, better treatability of industrial waste water and better arrangements for disposal of treated effluents are some of the advantage of the joint treatment of industrial and domestic effluents.
- Contribution from industries to capital expenditure of laying sewers and construction of treatment plant would render finance to sewerage and treatment schemes.

- Joint treatment is attractive for cities and towns and industrial areas surrounded by residential areas.
- Baroda and Ahmedabad cities have such joint treatment schemes under a notified charging formula.
- It is considered that for small-scale industries located in cities, such joint collection and treatment is a win-win option. For medium and large industries wherever possible such joint collection and treatment would improve, besides other technical advantages, the financial viability of the city sewerage and treatment system.

11. Step – X Pollution from non-point sources

- It is also extremely important to focus attention upon the problem of non-point pollution from unsewered sanitation, uncollected wastes dumped haphazardly in urban and industrial areas and apllication of chemicals in agriculture such as pesticides, insecticides and chemical fertilisers.
- Presence of unacceptably high levels of the persistent pollutants in the groundwater and run-off waterthese are likely to increase with greater application of these commodities in the future.
- In this regard it is essential that an integrated pest management policy should be evolved and standards made to regulate the use of toxic pesticides and to develop substitutes which are ecologically more acceptable.

12. Step – XI Some other Important Options for Water Quality Management

In majority of cases establishment of sewage treatment plant and its proper operation alone may not be adequate to maintain or restore water quality in a water body. In such case multipronged approach is required to ensure restoration of water quality. Some of the options that are available are provided in **Annexure 5.**

Annexure 1

Procedure for setting water quality goals

The term "water quality" is a widely used expression, which has an extremely broad spectrum of meanings. Each individual has vested interests in water for his particular use. The term quality therefore, must be considered relative to the proposed use of water. From the user's point of view, the term "water quality" is defined as "those physical, chemical or biological characteristics of water by which the user evaluates the acceptability of water". For example for the sake of man's health, we require that his water supply be pure, wholesome, and potable. Similarly, for agriculture, we require that the sensitivity of different crops to dissolved minerals and other toxic materials is known and either water quality other type of crops is controlled accordingly. Textiles, paper, brewing, and dozens of other industries using water, have their specific water quality needs.

For management of water quality of a water body, one has to define the water quality requirements or water quality goal for that water body. As mentioned above, each water use has specific water quality need. Therefore, for setting water quality objectives of a water body, it is essential to identify the uses of water in that water body. In India, the Central Pollution Control Board (CPCB), an appex body in the field of water quality management, has developed a concept of "designated best use". According to which, out of several uses a particular water body is put to, the use which demands highest quality of water is called its "designated best use" , and accordingly the water body is designated. The CPCB has identified 5 such "designated best uses". All those water bodies, which are used for drinking without any treatment, but with disinfection (chlorination), are termed as "A" Class Water, those which are used for outdoor bathing are termed as "B" Class Water, those which are used for drinking after conventional treatment are termed as "C" Class Water, those which are used for propagation of wildlife and fisheries are termed as "D" Class Water and those which are used for irrigation, cooling and controlled waste disposal are termed as "E" Class Water. For each of these five "designated best uses" , the CPCB has identified water quality requirements in terms of few chemical characteristics, known as primary water quality criteria. The "designated best uses" along with respective water quality criteria is given in Table 1.

Table 1 : Use based classification of surface waters in India

Designated-Best-Use	Class of water	Criteria
Drinking Water Source without conventional treatment but after disinfection	A	1. Total Coliforms OrganismMPN/100ml shall be 50 or less 2. pH between 6.5 and 8.5 3. Dissolved Oxygen 6mg/l or more 4. Biochemical Oxygen Demand 5 days 20oC 2mg/l or less
Outdoor bathing (Organised)	B	1. Total Coliforms Organism MPN/100ml shall be 500 or less 2. pH between 6.5 and 8.5 3. Dissolved Oxygen 5mg/l or more 4. Biochemical Oxygen Demand 5 days 20oC 3mg/l or less
Drinking water source after conventional treatment and disinfection	C	1. Total Coliforms Organism MPN/100ml shall be 5000 or less 2. pH between 6 to 9 3. Dissolved Oxygen 4mg/l or more 4. Biochemical Oxygen Demand 5 days 20oC 3mg/l or less
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 25oC micro mhos/cm Max.2250 3. Sodium absorption Ratio Max. 26 4. Boron Max. 2mg/l

The CPCB, in collaboration with the concerned State Pollution Control Boards, has classified all the water bodies including coastal waters in the country according to their "desiganed best use". This classification helps the water quality managers and planners to set water quality targets and identify needs and priority for water quality restoration programmes for various water bodies in the country. The famous Ganga Action Plan and subsequently the National River Action Plan are results of such exercise.

Annexure - 2

Water Quality Monitoring Protocol

1 Introduction

The main objectives for water quality monitoring for Surface and Groundwater Agencies under the HP were identified as:

- monitoring for establishing baseline water quality
- observing trend in water quality changes
- calculation of flux of water constituents of interest
- surveillance for irrigation use
- control and management of water pollution (for groundwater only)

The networks of monitoring stations were designed/upgraded accordingly with the above objectives in mind.

The present document summarises the design approach and delineates actions necessary to operationalise the monitoring programme.
The document is meant to be used as a ready reference by the field staff, water quality laboratory personnel and managers of the water quality monitoring programmes.

2 Frequency and Parameters

2.1 Groundwater

- Initially all stations will be classified as *baseline* stations.
- About 20 to 25% of the baseline stations will also be classified as *trend* or *trend-cum-surveillance* stations.
- Table 1 gives the frequency of sampling and parameters for various types of stations.
- After data are collected for three years, the stations may be reclassified. Some *baseline* stations may be discontinued for a fixed number of years and some *baseline-cum-trend* stations may be operated only as *trend* stations. Suspect wells may be operated as *trend-cum-surveillance* stations.

2.2 Surface Water

- Since not much is known about the present water quality status at various stations, to start with, all stations will be a combination of *baseline* and *trend* stations.
- Samples will be collected every two months: May/June, August, October, December, February, and April. This will generate six samples from perennial rivers and 3-4 samples from seasonal rivers, every year.
- After data are collected for three years, the stations will be classified either as *baseline, trend* or *flux* station.
- Those stations, where there is no influence of human activity on water quality, will be reclassified as *baseline* stations. Others will remain as *trend* stations.
- If a station is classified as a *baseline* station, it will be monitored, after every three years, for one year every two months.
- If a station is classified as *trend* station, it will continue to be monitored but with an increased frequency of once every month.
- Stations will be classified as *flux* stations where it is considered necessary to measure the mass of any substance carried by the flow. The frequency of sampling at such stations and analyses of constituents of interest may be increased to 12 or 24 times per year. Measurement of discharge at such stations is necessary.
- The recommended parameters for analysis are given in Table 2.
- Other inorganics, metals, organics and biological parameters will be determined as part of special *survey* programmes.
- The *survey* programmes may include some of the trend stations where there is a need for determination of any of these groups of parameters.

- The *survey* programmes will ordinarily be of one year duration. The sampling frequency may be the same as that for trend stations.
- Special arrangements for sampling and transport of the samples would be necessary for the *survey* programmes and microbiological samples.

Table 1 Parameters of analysis for groundwater samples

Type of station	Frequency	Parameter
Baseline	Once every year, (pre-monsoon, May-June)	Temp, EC, pH, $NO_2^- + NO_3^-$, total P, K^+, Na^+, Ca^{++}, Mg^{++}, CO_3^{--}, HCO_3^-, Cl^-, SO_4^{--}, COD, SiO_2, F, B.
Trend	Four times every year, (pre-monsoon, May-June & after intervals of 3 months)	Temp, EC, pH, $NO_2^- + NO_3^-$, total P, Cl^-, COD.
Trend–cum–surveillance	Minimum four times a year (as above), higher frequency if dictated by importance of water use	According to the problem under surveillance (e.g. Heavy metals in mining areas)
– ***Fluoride***		F^-
– ***Iron***		Fe
– ***Industrial, mining***		As, Cd, Hg, Zn
– ***Salinity due to irrigation, natural contribution or sea water intrusion***		Na^+, K^+, Ca^{++}, Mg^{++}, CO_3^{--}, HCO_3^-, Cl^-, SO_4^{--}
– ***Urban pollution***		Total and faecal coliforms

Table 2 Parameters of analysis for surface water samples[a]

Parameter Group	**Initially**	**Baseline**	**Trend**
General	Temp, EC, pH, DO,TDS	Temp, EC, pH, DO,TDS	Temp, EC, pH, DO
Nutrients	NH_3-N, $NO_2 + NO_3$, total P	NH_3-N, $NO_2 + NO_3$, total P	NH_3-N, $NO_2 + NO_3$, total P
Organic matter	BOD, COD	None	BOD, COD
Major ions	Ca^{++}, Mg^{++}, K^+, Na^+, CO_3^{--}, HCO_3^-, Cl^-, SO_4^{--}	Ca^{++}, Mg^{++}, K^+, Na^+, CO_3^{--}, HCO_3^-, Cl^-, SO_4^{--}	Cl^-
Other inorganics	None	None	None
Metals	None	None	None
Organics	None	None	None
Microbiological[b]	Total coliforms	None	Total and faecal coliforms
Biological	None	None	None

a- based on ‘Surface Water Quality Network Design, Guidelines and an Example’, June 1997
b- depending on workload, analysis frequency may be reduced upto 2 samples per year

3 Sample Collection

3.1 GENERAL

- At least one day before sampling, make sure that all the arrangements are made as per the check list given in Annexure I.
- Make sure that you know how to reach sampling site(s). Take help of location map for the site which shows the sample collection point with respect to prominent landmarks in the area. In case there is any deviation in the collection point, record it on the sample identification form giving reason.
- Rinse the sample container three times with the sample before it is filled.
- Leave a small air space in the bottle to allow mixing of sample at the time of analysis.
- Label the sample container properly, preferably by attaching an appropriately inscribed tag or label. The sample code and the sampling date should be clearly marked on the sample container or the tag.
- Complete the sample identification forms for each sample, Figures 1 and 2 for ground and surface water, respectively.
- The sample identification form should be filled for each sampling occasion at a monitoring station. Note that if more than one bottle is filled at a site, this is to be registered on the same form.
- Sample identification forms should all be kept in a master file at the level II or II+ laboratory where the sample is analysed.

3.2 Groundwater

- Samples for groundwater quality monitoring would be collected from one of the following three types of wells:
  - *Open dug wells* in use for domestic or irrigation water supply,
  - *Tube wells* fitted with a hand pump or a power-driven pump for domestic water supply or irrigation
  - *Piezometers*, purpose-built for recording of water level.
- Open dug wells, which are not in use or have been abandoned, will not be considered as water quality monitoring station. However, such wells could be considered for water level monitoring.
- Use a weighted sample bottle to collect sample from an open well about 30 cm below the surface of the water. Do not use a plastic bucket, which is likely to skim the surface layer only.
- Samples from the production tube wells will be collected after running the well for about 5 minutes.
- Non-production piezometers should be purged using a submersible pump. The purged water volume should equal 4 to 5 times the standing water volume, before sample is collected.
- For bacteriological samples, when collected from tubewells/hand pump, the spout/outlet of the pump should be sterilized under flame by spirit lamp before collection of sample in container.

3.3 Surface Water

- Samples will be collected from well-mixed section of the river (main stream) 30 cm below the water surface using a weighted bottle or DO sampler.
- Samples from reservoir sites will be collected from the outgoing canal, power channel or water intake structure, in case water is pumped. When there is no discharge in the canal, sample will be collected from the upstream side of the regulator structure, directly from the reservoir.
- DO is determined in a sample collected in a DO bottle using a DO sampler. The DO in the sample must be fixed immediately after collection, using chemical reagents. DO concentration can then be determined either in the field or later, in a level I or level II laboratory.

3.4 Sample Containers, Preservation and Transport

- Use the following type of containers and preservation:

Analysis	Container	Preservation
General	Glass, PE	None
COD, NH_3, NO_2^-, NO_3^-	Glass, PE	H_2SO_4, pH<2
P	Glass	None
DO	BOD bottle	DO fixing chemicals
BOD	Glass, PE	4 ^oC, dark
Coliform	Glass, PE, Sterilised	4 ^oC, dark
Heavy metals	Glass, PE	HNO_3, pH<2
Pesticides	Glass, Teflon	4 ^oC, dark

- Samples should be transported to concerned laboratory (level II or II+) as soon as possible, preferably within 48 hours.
- Analysis for coliforms should be started within 24 h of collection of sample. If time is exceeded, it should be recorded with the result.
- Samples containing microgram/L metal level, should be stored at 4^{o}C and analysed as soon as possible. If the concentration is of mg/L level, it can be stored for upto 6 months, except mercury, for which the limit is 5 weeks.
- Discard samples only after primary validation of data.

Figure 1 Sample identification form for groundwater samples

Sample code		
Observer	Agency	Project
Date Time	Station code	
Source of sample: o Open dug well o Hand pump o Tube well o Piezometer		

Parameter Code	**Container**				**Preservation**				**Treatment**		
	Glass	**PVC**	**PE**	**Teflon**	**None**	**Cool**	**Acid**	**Other**	**None**	**Decant**	**Filter**
(1) Gen											
(2) Bact											
(3) BOD											
(4) COD, NH_3, TO_xN											
(5) H Metals											
(6)Tr Organics											

Field determinations			
Temp ^{o}C	**pH**	**EC µmho/cm**	**DO mg/L**

Odour Code			**Colour code**		
	(1) Odour free	(6) Septic		(1) Light brown	(6) Dark green
	(2) Rotten eggs	(7) Aromatic		(2) Brown	(7) Clear
	(3) Burnt sugar	(8) Chlorinous		(3) Dark brown	(8) Other (specify)
	(4) Soapy	(9) Alcoholic		(4) Light green	
	(5) Fishy	(10) Unpleasant		(5) Green	

IF WELL IS PURGED, COMPLETE BELOW:

Office Well Data			
Diameter	φ		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 (V/PQ)	PT		min
Field Flow Measurements			
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 (°C)	EC(μmho/cm)	pH
+10 min			
+20 min			
+30 min			
+40 min			

Figure 2 Sample identification form for surface water samples

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) Gen											
(2) Bact											
(3) BOD											
(4) COD, NH_3,NO_3^-											
(5) H. Metals											
(6)Tr. Organics											

Source of sample				
Waterbody	***Point***	***Approach***	***Medium***	***Matrix***
o River o Drain o Canal o Reservoir	o Main current o Right bank o Left bank	O Bridge O Boat O Wading	o Water o Susp matter o Biota o Sediment	o Fresh o Brackish o Salt o Effluent
Sample type	o Grab o Time-comp o Flow-comp o Depth-integ o Width-integ			
Sample device	o Weighted bottle o Pump o Depth sampler			

Field determinations					
Temp °C	**pH**	**EC μmho/cm**		**DO mg/L**	
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	o Sunny o Cloudy o Rainy o Windy
Water vel. m/s	o High (> 0.5) o Medium (0.1-0.5) o Low (< 0.1) o Standing
Water use	o None o Cultivation o Bathing & washing o Cattle washing o Melon/vegetable farming in river bed

4 Analysis and Record

4.1 Sample Receipt Register

- Each laboratory should have a bound register, which is used for registering samples as they are received.
- An example of headings and information for such a register is given in Figure 3.

Figure 3: Sample receipt register

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)
02.07.99/1400	01.07.99/1100	M 22	WQ monitoring	SW Div II/ Singh	No	1	28-1
02.07.99/1400	01.07.99/1700	M 24	WQ monitoring	SW Div II/ Singh	No	1	29-1
02.07.99/1400	01.07.99/1700	M 24	WQ monitoring	SW Div II/ Singh	Yes	4	29-4
05.07.99/1100	02.07.99/1300	S 44	Survey A	SPCB/ Bhat	Yes	5	30-5

- 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 number 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.
- 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 time of sample collection.

4.2 Work Assignment and Personal Registers

- The laboratory incharge should maintain a bound register for assignment of work. This register would link the lab. sample number to the analyst who makes specific analyses, such as pH, EC, BOD, etc.
- An estimate of time needed for performing the analyses may also be entered in the register.
- Each laboratory analyst should have his/her own bound register, where all laboratory readings and calculations are to be entered.
- When analysis and calculations are completed, the results must be recorded in a register containing data record sheets described in the next section.

4.3 Analysis Record and Data Validation

- A recommended format for recording data is given in Figure 4. It includes all parameters, except heavy metals and trace organics, that may be analysed in the water quality monitoring programme currently envisaged. Note that ordinarily a sample would NOT be analysed for all the listed parameters.
- Record of analyses for heavy metals and trace organics, which would be performed on a limited number of samples, would be kept separately in a similar format.
- Columns (2) – (3) are filled from the entries in the Sample Receipt Register.
- Columns (4) – (9) pertain to the field measurements. This information would be available from the Sample Identification Forms.
- Columns (10) – (36) would be filled in by the analyst(s) whom the work has been assigned (see Work Assignment Register).
- The format also includes primary data validation requirements, columns (37) – (53). The laboratory incharge should perform these validation checks as the analysis of a sample is completed. In case the analysis results do not meet any one of the validation checks, whenever possible, the analysis should be repeated. She/he would also fill in Columns (54) – (55).
- The results of the laboratory analyses would be entered from these records in the data entry system.

Figure 4: Data record and validation register

Data record **Laboratory / organisation** **Laboratory code**

			Field determinations						General				Nutrients			Org matter		Alkalinity		Hardness		Major ions								Other inorganics			Coliforms		Biol
Lab sample No	Station code	Date of collection	pH	EC, µmho/cm	DO, mg/L	Temp, °C	Colour, code	Odour, code	pH	EC, µmho/cm	TDS, mg/L	TSS, mg/L	NH_3, mg N/L	NO_2^-+NO_3^-, mg N/L	Total P, mg/L	BOD, mg/L	COD, mg/L	Phen, mg $CaCO_3$/L	Total, mg $CaCO_3$/L	Total, mg $CaCO_3$/L	Ca^{++}, mg $CaCO_3$/L	Ca^{++}, mg/L	Mg^{++}, mg/L	Na^+, mg/L	K^+, mg/L	Cl^-, mg/L	SO_4^{--}, mg/L	CO_3^{--}, mg/L	HCO_3^-, mg/L	Si, mg/L	F^-, mg/L	B, mg/L	Total, MPN/100 mL	Faecal, MPN/100mL	Chlorophyll-A, µg/L
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)	(36)

Data validation

		Cations					Anions						Ion balance		EC bal	Carbon bal	CO_3^{--} bal	Verification criteria	Checked by	Remarks
Lab sample No	Station code	Ca^{++}, meq/L	Mg^{++}, meq/L	Na^+, meq/L	K^+, meq/L	Total cations	Cl^-, meq/L	SO_4^{--}, meq/L	CO_3^{--}, meq/L,	HCO_3^-, meq/L	NO_2^-+NO_3^-, meq/L	Total anions	{(41)-(47)} / {(41)+(47)}	(39) / (42)	(12) / (11)	(18) / (17)	If (10) < 8.3, is (19)=0 ?			
(1)	(2)	(37)	(38)	(39)	(40)	(41)	(42)	(43)	(44)	(45)	(46)	(47)	(48)	(49)	(50)	(51)	(52)	(53)	(54)	(55)
																		(48) < 0.1 (49) = 0.8-1.2 (50) = 0.55-0.9 (51) > 1 (52) = yes		

Annexure I

Checklist for sampling

- The following is a list of items, which should be checked before starting on a sampling mission.

- Itinerary for the trip (route, stations to be covered, start and return time)
- Personnel and sample transport arrangement
- Area map
- Sampling site location map
- Icebox
- Weighted bottle sampler
- DO sampler
- Rope
- BOD bottles
- Sample containers
- Special sample containers: bacteriological, heavy metals, etc.
- DO fixing and titration chemicals and glassware
- Thermometer
- Tissue paper
- Other field measurement kit, as required
- Sample identification forms
- Labels for sample containers
- Field notebook
- Pen / pencil / marker
- Soap and towel
- Match box
- Spirit lamp
- Torch
- Drinking water
- Knife

- Note that depending on the local conditions, water body, analysis requirements, etc., all items may not be necessary, or other items, not listed, may be required.
- Decide on the number of each item that would be required depending on the number of samples to be collected. It is always safer to carry a few numbers in excess.
- Ensure that the concerned laboratory is informed of the programme and ready to receive samples, particularly those, which would need immediate attention.

ANNEXURE-2

MINISTRY OF ENVIRONMENT AND FORESTS

New Delhi, the 17 June, 2005

S. O. 2151.— 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 27th 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, 1974 (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 may 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)

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 measurements 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 for national water bodies restricted to surface and ground water in the country.

4. Monitoring station and frequency of sampling.-

(2)

(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 times 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

1	2	3
Type of Station	**Frequency**	**Parameters**
Baseline	**Perennial rivers and Lakes:** Four times a year (seasonal) **Seasonal rivers:** 3-4 times (at equal spacing) during flow period **Lake** 4 times a year (seasonal)	**(A) Pre-monsoon**: Once a 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** : Ammonical Nitrogen (NH_4-N), Nitrite & Nitrate 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), Carbonate (CO_3), Bicarbonate (HCO_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_2 + NO_3, BOD, Total coliform and Faecal Coliform.
Trend or Impact or Flux	Once every month 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_4-N, NO_2 + NO_3, Total P **(c)Organic Matter**: BOD, COD **(d)Major ions** : Cl **(e)Microbiological** : Total and Faecal coliforms **(C)Micropollutant** :Once in a year / pre monsoon

(3)

		(i)Pesticides-Alpha Benzenehexachloride (BHC), Beta BHC, Gama BHC (Lindane), OP-Dichlorodiphenyltrichloroethane (OP-DDT), PP-DDT, Alpha Endosulphan, Beta Endosulphan, Aldrin, Dieldrin, Carbaryl (Carbamate), Malathian, Methyl Parathian, Anilophos, Chloropyriphos **(ii)Toxic Metals**-Arsenic (As), Cadmium (Cd), Mercury (Hg), Zinc (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 be 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 follow 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

1	2	3
Type of Station	Frequency	Parameters
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: NO2 + NO3, orthophosphate (c) Demand Parameter: COD (d) Major Ions: Na+, K+, Ca++, Mg++, CO3⁻, HCO3⁻, Cl⁻, SO4⁻ %Na & SAR (e) Other inorganics: F, B and other location-specific parameter, if any
Trend	Twice a year (pre and post	(A) April-May: Analyse 20 parameters as listed for Baseline monitoring. (B) Other times: Analyse 14 parameters as listed below:-

rol Board, Delhi

	monsoon)	(i) General: Colour, odour, temp, EC, pH, TDS, %Na & SAR (a) Nutrients: NO2+NO3, orthophosphate (b) Demand parameter: COD (c) Major ions : Cl (d) Other inorganics : F,B (e) Microbiological: Total coliform and faecal coliform (C) Micropollutants (parameters may be selected based on local need) : (2) Pesticides - Alpha BHC, Beta, BHC, Gama BHC (Lindane), OP-DDT, PP-DDT, Alpha Endosulphan, Beta Endosulphan, Aldrin, Dieldrin, 2, 4-D, Carbaryl (Carbamate), Malathion, Methyl, Parathion, Anilphos, Chloropyriphos (3) Toxic Metals-As, Cd, Hg, Zn, Cr, Pb, Ni, Fe (Pesticides and Toxic metals may be analysed 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 Chemcial 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 stem 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.

(5)

(c) samples from the production tube wells shall be collected after running the well for about five minutes.

(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	4^0C, dark
BOD	Glass, PE	4^0C, dark
COD, NH_3, NO_2, NO_3	Glass, PE	H_2SO_4, PH<2
Coliform	Glass, PE, Sterilised	4^0C, dark
DO	BOD bottle	DO fixing chemicals
Fluoride	PE	None
P	Glass	None
Pesticides	Glass, Teflon	4^0C, 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 coliforms shall be started within twenty-four hours of collection of sample. If time is exceeded, it should be recorded with the result.

(2) Samples containing microgram/l metal level should be stored at 4^0C and analyzed as soon as possible. If the concentration is of mg/l 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-II.

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.

(6)

8. Analytical techniques.

Each agency shall follow the analytical techniques prescribed in the Standard Methods for Analysis of Water and Wastewater published by American Public Health Association(Latest Edition) or Bureau of Indian Standards(BIS) Methods for Testing Water and Wastewater-methods 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 in order to get the maximum utilization of mandays, for timely completion of 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 of 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. 15011/8/2004-NRCD]
M. SENGUPTA, Adviser

1714 GI/05—26

(7)

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_3, NO_3												
(5) Toxic Metals												
(6) Trace Organics												

Source of sample				
Water	Point	Approach	Medium	Matrix
0 River 0 Drain 0 Canal 0 Reservoir (lakes/tank/pond)	0 Main current 0 Right bank 0 Left bank	0 Bridge 0 Boat 0 Wading	0 Water 0 Suspended matter 0 Biota 0 Sediment	0 Fresh 0 Brackish 0 Salt 0 Effluent
Sample type	0 Grab 0 Time-comp 0 Flow-comp 0 Depth-integ 0 Width-integ			
Sample device	0 weighted bottle 0 Pump 0 Depth sampler			

Field determinations			
Temp °C	PH	EC micromhos/cm	DO mg/l
Odour Code	(1) Odour free (6) Septic (2) Rotten eggs (7) Aromatic (3) Burnt sugar (8) Chlorinous (4) Soapy (9) Alcoholic (5) Fishy (10) Unpleasant	Colour code	(1) Light brown (6) Dark green (2) Brown (7) Clear (3) Dark brown (8) Other (4) Light green (specify) (5) Green

Remarks	
Weather	0 Sunny 0 Cloudy 0 Rainy 0 Windy
Water vel. M/s	0 High (> 0.5) 0 Medium (0.1-0.5) 0 Low (< 0.1) 0 Standing
Water use	0 None 0 Cultivation 0 Bathing & washing 0 Cattle washing 0 Melon/vegetable farming in riverbed. 0 Organised water supply

(8)

FORM-II

Sample identification for ground water samples.

Sample code											
Observer	Agency						Project				
Date	Time			Station code							
Source of sample: 0 Open dug well 0 Hand pump 0 Tube well 0 Piezometer											
Parameter code	Container				Preservation				Treatment		
	Glass	PVC	PE	Tef-lon	None	Cool	Acid	Other	None	Decant	Filter
(1) General											
(2) Bacteriological											
(3) BOD											
(4) COD, NH_3, NO_3											
(5) Toxic Metals											
(6) Tr. Organics											

Field determinations			
Temp °C	PH	EC micromho/cm	DO mg/l
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)

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 (V/PQ)	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 (°C)	EC (micromho/cm)	pH
+10 min			
+20 min			
+30 min			
+40 min			

(९)

FORM-III
Sample Record for Analysis

Date/Time received at lab.	Date/Time collected	Station code	Project	Collecting agency / collector	Pre-servation	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 time of sample collection

(14)

FORM-IV

Section	Group	Parameter	No.
Data record			1
			2
	Date of collection		3
	Field determination	pH	4
		EC, micromohs/cm	5
		DO, mg/l	6
		Temp, °C	7
		Colour, code	8
		Odour, code	9
Laboratory/[illegible]	General	pH	10
		EC, umho/cm	11
		TDS, mg/l	12
		TSS, mg/l	13
	Nutrients	NH_4, mg N/l	14
		NO_2, NO_3, mg N/l	15
		Total, mg/l	16
	Org matter	BOD, mg/l	17
		COD, mg/l	18
	Alkalinity	Phen, mg $CaCO_3$/l	19
		Total, mg $CaCO_3$/l	20
	Hardness	Total, mg $CaCO_3$/l	21
		Ca^{++}, mg $CaCO_3$/l	22
Laboratory code	Major ions	Ca^{++}, mg/l	23
		Mg^{++}, mg/l	24
		Na^{+}, mg/L	25
		K^{+}, mg/l	26
		Cl^{-}, mg/l	27
		SO_4, mg/L	28
		CO_3, mg/l	29
		HCO_3, mg/l	30
	Other inorganics	Si, mg/l	31
		F, mg/l	32
		B, mg/l	33
	Coliforms	Total, MPN/100 ml	34
		Faecal, MPN/100ml	35
	Bio	Chlorophyll-A, mg/l	36

Data validation

Group	Parameter	No.
Lab sample No.		1
Station code		2
Cations	Ca^{++}, meq/l	37
	Mg^{++}, meq/l	38
	Na^{+}, meq/l	39
	K^{++}, meq/l	40
	Total cations meq/l	41
Anions	Cl^{-}, meq/l	42
	SO_4, meq/l	43
	CO_3, meq/l	44
	HCO_3, meq/l	45
	NO_3+NO_2, meq/l	46
	Total anions meq/l	47
Ion balance	{(41)-(47)}/{(41)+(47)}	48
TDS/EC Ratio	(12)/(11)	49
BOD/COD Ratio	(17)/(18)	50
PH. Vs. Alkalinity Ratio	If (10) > 8.3, ie (19)>0?	51
CO3 [illegible]		52
Verification criteria	(48) (49) (50) (51) 1-2?	53
Checked by		54
Remarks		55

(10)

Polluted River Stretches Identification And Action Plan to Control of Water Pollution

For rational planning of any pollution control programme, complete knowledge of nature and magnitude of pollution is pre-requisite. To acquire such knowledge it is essential that a sound scientific water quality monitoring programme is established. The monitoring programme also helps prioritising pollution control efforts, establishing water quality trends and evaluating effectiveness of pollution control measures already in existence. Realizing this fact, CPCB in collaboration with concerned State Pollution Control Boards has initiated water quality monitoring at limited number of locations. The monitoring network was gradually augmented. At present there are 784 locations. The monitoring data are annually compiled, analysed and compared with desired water quality in different water bodies. Where-ever, gaps are observed especially with respect to pollution related indicators like Biochemical Oxygen Demand (BOD) the water body is identified as polluted.

It is important to concentrate and prioritise pollution control efforts in order of merits. In 1988-89, CPCB identified 10 problem areas and 10 polluted river stretch to concentrate the pollution control efforts the list of polluted stretches formed the basis for formulation of River Action Plan of the National River Conservation Directorate. The list was further extended based on increasing pollution problem in our country.

In the present exercise those water bodies having BOD more than 6 mg/l are identified as polluted water bodies. A list of such water bodies is attached.

The respective State Pollution Control Boards/ Pollution Control Committee's were requested to formulate action plan to restore the water quality of the water bodies. This is for kind information of the Board.

List of Polluted River Stretches

River	Polluted Stretch	Source/Town	Critical Parameters (in mg/l)
Andhra Pradesh			
River			
1.Godavari	• Polavaram to D/S of Rajamundary	Rajamundary & Polavaram Sewage	BOD - 6-12
2.Nagavalli	• Nagavalli along Thotapalli Regulator	Industrial & Domestic water from Rayagada	BOD- 6-10
3.Musi	• D/S of Hyderabad	Hyderabad- Securanderabad-Sewage	BOD- 16-44
Lake			
4.	• Kishtra Reddy Pet Tank, Medak	Medak Sewage	BOD- 9-28
5.	• Dharamsagar tank, Warangal	Warangal Sewage	BOD- 7.5-9.4
6.	• Hussain Sagar Lake	Hyderabad-Securandabad Sewage	BOD- 8-19
7.	• Sarronagar Lake	Ranga Reddy Hyderabad	BOD- 8.0-12.5
8.	• Pulicate Lake,Nellore	Nellore sewage	BOD- 8-12.1

A s s a m

River			
9.Kalong	• Elengabeel System	Nagaon- Sewage	BOD- 10-70
10.Bharalu	• D/S Guwahati	Guwahati Sewage	BOD- 38

D e l h i

River			
11.Yamuna	• Wazirabad to Okhla	Industrial & Domestic Waste from Delhi	BOD- 6-77

J h a r k h a n d

River			
12.Subarnrekha	• Ranchi to D/S of Jamshedpur	Industrial & domestic waste from ranchi & Jamshedpur	***BOD***

G u j a r a t

River			
13.Sabarmati	• Ahmedabad to D/s of Vautha	Discharge from Meshwa & Ahemdabad	BOD-56-504
	• Kankoria Lake,Ahemdabad	Municipal & Industrial waste from Ahemdabad	BOD-6-29
14.Amlakhadi	• Along Ankeshwar	Industrial & Domestic waste from Ankeshwar	BOD-138-920, Ammonia-117.6-201.60
15.Shedi	• Along Kheda	Kheda Sewage	BOD- 8-19
16.Damanganga	• Vapi D/S to Confl. with sea	Industrial & Domestic waste from Vapi,Salvas,Daman & Kachigaon	BOD- 9-10
17.Ambika	• Billimora D/S	Billimora Sewage	BOD- 18
18.Bhadar	• Jetpur to Ratia (Junagarh)	Jetpur & Dhoraji Sewage	BOD- 33
19.Khari	• Lali village, Ahemdabad		BOD-92-675
20.Kolak	• Vapi to Patalia.	Vapi Industrial township Phase – III,IV & Daman Industrial area	BOD- 11-35
21.Par	• Vapi to Patalia	Atul township & Industrial waste water, Pardi &Umarkhadi waste water	BOD- 27

H a r y a n a

River			
22.Ghaggar	• Interstate border with Punjab to Ottu wier at	Industrial & Municipal waste from Sirsa	BOD-8-50

	Sirsa		
23.Yamuna	• Okhla to Kosi Kalan	Industrial & Domestic waste from Faridabad & Palwal	BOD- 16
24.Drain No.8	• Sonepat to Confl. with Yamuna	Industrial & Domestic waste of Sonepat	BOD-6-36
Himachal Pradesh			
River			
25.Markanda	• Kala Amb D/S to Haryana Border	Industrial & Domestic waste from Kala Amb	BOD- 55 Colour- 1009 Hazen
Lake			
26.	• Renuka Lake		BOD- 8
Karnataka			
River			
27.Bhadra	• Maleshwaram to D/s of Bhadravathi	Industrial & Domestic waste from Bhadravathi	BOD- 7.2
28.Tunga	• D/S of Shimoga	Shimoga Sewage	BOD
29.Kali	• Along Dandeli Town	West Coast Paper Mill waste	BOD
30.Tungabhadra	• Harihar D/S to Hara eahalli Bridge.	Harihar Sewage & Grasim waste	BOD- 6-8
Lake			
31.	• Heballa Valley Lake, Mandya	Mandya Sewage	BOD- 6-36
32**.**	• Ulsoor Lake	Bangalore sewage	BOD- 6-18
M . P			
River			
33.Khan river	• Indore city to confluence with Kshipra	Indore-sewage	BOD- 65-120
34.Kshipra	• Ujjain to confluence with Chambal	Ujjain- sewage	BOD- 8-24]
35.Chambal	• D/S of Nagda	Industrial Waste – Grasim & Nagda Sewage	BOD- 8-24
36.Tapi	• D/S of Napanagar to Burhanpur city	Domestic & Industrial waste water from Nepanagar & Burhanpur	BOD
Lake			
37**.**	• Lower & upper Lake, Bhopal	Bhopal sewage	BOD- 6-8
Maharashtra			
River			
38.Godavari	• Nasik to(Raher) Nanded	Sewage from Nasik,	BOD- 6-66

		Chanderpur, Nanded, Raher	
39.Kalu	• Atale village to Confl. with Ulhas		BOD- 6-10
40.Ulhas	• Mohane to Baddapur	Industrial & Domestic runoff ulhasnagar	BOD- 6-8
41.Weinganga	• D/S Ashti	Ashti town	BOD- 6-7
42.Panchganga	• Along Ichalkaranji	Ichalkaranji	BOD - 7-25
43.Wardha	• Along Rajura village	Paper mill waste	BOD - 6-8
44.Bhima	• Pargaon to Confluence with river Daund	Pune - Sewage Nira – discharge	BOD - 6.5
45.Mula & Mutha	• D/s Pune city	City Sewage of Pune	BOD - 6.7
46.Bhatsa	• D/S of shahpur Industrial township.	Industrial township – Shahpur	BOD
47.Patalganga	• Khopoli to Esturaine region	Industrial & Municipal sewage from khopoli, Rasayani & Paundh	BOD – 6
48.Kundalika	• Along Roha city	Roha city sewage	BOD - 6-6.5
49.Krishna	• Dhomdam to Sangli	Sewage & Industrial waste from Karnal & Sangli	BOD - 6-8
50.Tapi	• M.P. Border to Bhusaval	Bhusaval Sewage	BOD - 6-9
51.Girna	• Malegaon to Confl.with Tapi	Malegaon Sewage	BOD - 6-12
52.Nira	• Along Pulgaon	Pulgaon Cotton Mill	BOD – 6-21

M e g h a l a y a

River

53.Kharkhala	• Near Sutnga Khlieri,Jaintia Hills		BOD – 8-10

Lake

54.	• Umiam Lake, Barapani	Sewage from Shillong	BOD 7-13
55.	• Ward Lake, Shillong		BOD 9-12.2
56.	• Umtrew lake, Byrnihat East		BOD - 7-9
57.	• Thadlaskena lake Shilong		BOD 7-9

O r i s s a

River

58.Brahmani	• Panposh D/S to Dharamsala	Sewage & Industrial waste from Panposh, Rourkela, Talcher, Dharamsala	BOD 6-7
59.Ib	• Sundargarh to Confl. With Mahanadi	Sewage & Industrial waste from Sundargarh, Jharsuguda, Brajrajnagar	BOD 6-9

60.Mahanadi	•	Cuttack D/S	Cuttack Sewage	BOD 6-8
61.Kuakhai	•	Along Bubhaneshwar	Bubhaneshwar – Sewage	BOD - 7
62.Kathjodi	•	Along Cuttack	Cuttack Sewage	BOD 6-12.3

P u n j a b

River

63.Satluj	•	D/S of Ludhiana	Sewage from Ludhiana and Jalandar	BOD 8-14.4
64.Beas	•	D/S of Mukorian	Industrial discharge from Goindwal and Mukarian	BOD-8.4-20
65.Ghaggar	•	Mubarkpur to Sardulgarh	Municipal & Industrial discharge from Patiala, Sukhna paper mills & Derra Bassi	BOD - 6.4-50

R a j a s t h a n

River

66.Ghaggar	•	Ottu weir to Hanumangarh	Industrial & domestic waste from Haryana & Punjab	BOD
67.Chambal	•	D/S Kota city	Industrial & Domestic waste from Kota	BOD 6-6.4
68.Banas / Berach river	•	Udaipur to Chittorgarh	Municipal waste from Udaipur & Chittorgarh	BOD
	•			

T a m i l N a d u

River

69.Vaigai	•	Along Madurai	Madurai-Industrial & domestic wastewater	BOD- 7-9
70.Palar	•	Vaniyambadi	Vaniyambadi - Industrial & Municipal Wastewater	BOD-
71.Adyar	•	Along Chennai	Chennai- Industrial & Municipal Wastewater	BOD
72.Coovum	•	Along Chennai	Chennai- Industrial & Municipal wastewater	BOD
73.Tambiraparani	•	Papavinasam to Arunuganeri	Madura Coats Indusitrial waste	BOD- 6-13
74.Noyyal	•	Along coimbatoor, Tirupur, Palyanakotti	Industrial & domestic wastewater from coimbatoor, Tirupur, Palyanakotti	BOD
75.Cauvery	•	D/s of Mettur Dam to Erode city	Municipal sewage of Erode	BOD- 6.4-7

Sikkim

River

76.Ranichu	• Along Ranipur	Municipal Wastewater Ranipur	BOD- 24

Uttar Pradesh

77.Yamuna	• Kosi Kalan to confl. with Chambal	Sewage from Agra, Vindravan, Mathura & Etawah	BOD- 6-37
78.Hindon	• Saharanpur to Confl. With Yamuna	Sewage & Industrial effluent from Saharanpur, Muzaffur Nagar & Ghaziabad	BOD- 9-36
79.Western Kali	• Muzaffar Nagar to Confluence with Hindon	Sewage & Industrial effluents from Muzaffar nagar & Mansoorpur	BOD- 21-44
80.Buri Yamuna	• Pilkhani to Confluence with Yamauna	Industrial effluent of Pilkhani Distillary	BOD
81.Kali Nadi Eastern	• Merrut to Kannauj	Industrial and Municipal sewage from , Meerut, Modi nagar, Bulandsahar, Hapur, Gulwati and Kannauj	BOD- 43-135
82.Gomti	• Lucknow to Confluence with Ganga	Sewage & Industrial effluent from Lucknow, Sultanpur, Jaunpur.	BOD 6-8.2 BOD 6-7.6
83.Ganga	• Kannauj to Kanpur D/S	Discharge through Kalinadi & Ramganga sewage & Industrial effluent from Kannauaj and Kanpur	BOD 6-10
84.	• Varanasi D/s	Varanasi sewage & Industrial effluent	BOD 6.5- 16.5

West Bengal

River

85.Damodar	• Durgapur to Haldia	Industrial waste & sewage from Durgapaur & Asansol	BOD 6.4-32

Annexure 4

Guidelines for Assessment of Pollution Sources and Estimation of Pollution Load in a Polluted Stretch

1. Identification of Sources of Pollution

Demarcate location of cities and towns and industrial units on the identified polluted stretches.

2. Industrial Pollution

(A) Large & Medium Industries

i. Listing of polluting industries
ii. Pollution load from those industries covering the following parameters
   a) ***Volume of Waste water generated from each industrial unit.***
   b) Influent and Effluent Quality of wastewater from each industrial unit in terms of wastewater from each industries unit in terms of BOD, COD, Conductivity, Heavy Metals, Toxic Chemicals, Pesticides etc.
iii. Treatment Technology adopted and Process
iv. Utilisation of Wastewater

(B) Small Scale Industries

i. Listing of polluting industries and volume of wastewater generated from cluster of small scale industries
ii. Quality of effluents generated from each small-scale industries in terms of BOD, COD, Conductivity, Heavy Metals, Toxic Chemicals, Pesticides etc.
iii. Possibility of application of Common Effluent Treatment Plants for such clusters.

3. Domestic Pollution

i. Identification of Major outfall points with their locations
ii. Quality and quantity of municipal wastewater discharging in a water body.
iii. Identification of extent of pollution control needed in view of critical flow conditions and comparing with desired quality criteria
iv. Utilisation of wastewater and Volume of wastewater used for agriculture

4. River Water Quality

i. River flow in the identified stretches.
ii. Quality of river water with critical parameter in the identified stretches
iii. Projected quality of river water in those stretches if effluents are either diverted or discharged after adequate treatment only
iv. Assessment of the fraction of Industrial Pollution load contributing towards municipal wastes
v. Compare water quality with desired classes of water for beneficial uses

5. Treatment of Municipal Wastewater

Identification of land for construction of STP's and Treatment technology to be adopted.

6. Post Project Monitoring

Water quality monitoring of rivers/water bodies/STP's to be carried out on regular basis to evaluate the performance of

Some Important Options for Restoration of Water Quality in a Water Body

1. Reuse/recycling of treated domestic sewage:

- Cities/towns discharging wastewater should treat the wastewater suitably for land application and dispose of such water on land to the maximum extent possible. In cases where waste water is to be discharged into a water body, the degree of treatment will have to be higher, keeping in view the low quantity of available water for dilution and abstraction points downstream, etc.

- If the city does not have adequate land for irrigation due to increased urbanisation, the neighboring states may be approached. The fresh water so saved from irrigation could be utilised for meeting the drinking water requirements or for ensuring minimum flow in river.

- It is felt that the dilution of effluents is not a practical and economically viable solution to the problem that domestic and industrial effluents be adequately treated for re-use, for irrigation, industries, etc.

- Where irrigation from treated sewage is not feasible, the possibility of recharging ground water aquifer by sewage, treated to a certain desirable level, may be explored by taking up some experimental studies.

Water Conservation

Incentives for Water conservation

If water is available in abundance, there is a usually tendency to use it carelessly. Along with the measures towards pollution abatement it is imperative to further intensify our efforts for conservation of water to prevent water scarcity in surface water sources and ground water depletion. At present the consumer has little incentive to conserve water, as water tariffs are very low. In addition to appropriate pricing of water to reduce water demand in the household sector, there is a need to develop and implement such cost-effective water appliances as low-flow cisterns and faucets and formulate citizen forum groups to encourage and raise awareness on water conservation. Price of water should reflect its scarcity value and environmental costs. It is very important to reduce water use through pricing. The need is to develop surface irrigation sources and take measures for rainwater harvesting and preventing water run-offs. The amount unit area run-off from various basins of India very widely reflects the spatial distribution of annual rainfall. Moreover, the rivers of the country carry about 80% during the monsoon months of June-September and generally in excess of 90% during the period of June-November. Hence, the run-off can be tapped by building appropriate water harvesting structures in the lower reaches to trap the water. However, there are certain constraints associated with rainwater harvesting in terms of the capacity of soil to absorb large quantities of water in a shorter time frame, quality of the harvested water for drinking water purpose, and the cost involved with building such harvesting structures. There is no doubt that water harvesting is a highly desirable solution but it is an iota solution to a holistic problem of water scarcity.

Measures to Conserve Water

Following measures may be considered for combating water scarcity in 11th Plan:

a) Traditional Practices for Water Conservation
b) Suggested Water Conservation Measures
c) Surface Storage
d) Conservation of rain water
e) Ground water conservation
f) Artificial recharge
g) Percolation tank method
h) Catchment area protection (CAP)
i) Inter-basin transfer of water
j) Adoption of drip sprinkler irrigation
k) Management of growing pattern
l) Selection of crop varieties
m) Nutritional management

n) Role of Antitranspirants
o) Reducing evapotranspiration
p) Reducing evaporation
q) Recycling of wastewater
r) Conservation of water in domestic use

Wastewater as a resource
Since, there is no dilution available in the receiving water bodies, it is important that no wastewater is discharges into them even after treatment. The efforts should be to use entire wastewater after proper treatment. There are many cases where the sewage or industrial wastewater is treated and used for various inferior uses. Many companies are coming in this business. Focus should be to promote such business. This will benefit the water quality in many ways:

1. reduce pollution
2. save water
3. save nutrients
4. reduce over-exploitation of water resources

Wastewater Use in Agriculture
The incorporation of wastewater use planning into national water resource and agricultural planning is important, especially where dilution water in the receiving water bodies shortages exist. This is not only to protect sources of high quality waters but also to minimize wastewater treatment costs, safeguard public health and to obtain the maximum agricultural and aquacultural benefit from the nutrients that wastewater contains. Since in most of the urban centres, treatment plants either do not exist or not adequate. Wastewater use may well help reduce costs, especially if it is envisaged before new treatment works are built, because the standards of effluents required for various types of use may result in costs lower than those for normal environmental protection. The use of wastewater has been practiced in many parts of the country for centuries. Unfortunately, this form of unplanned and, in many instances unconscious, reuse is performed without any consideration of adequate health safeguards, environmentally sound practices or basic agronomic and on-farm principles. Authorities, particularly the Ministries of Health and Agriculture, should investigate current wastewater reuse practices and take gradual steps for upgrading health and agronomic practices. The implementation of an inter-sectoral institutional framework is the next step that should be taken. This entity should be able to deal with technological, health and environmental, economic and financial, and socio-cultural issues. It should also assign responsibilities and should create capacity for operation and maintenance of treatment, distribution and irrigation systems, as well as for monitoring, surveillance and the enforcement of effluent standards and codes of practice. In places with little or no experience on planned reuse, it is advisable to implement and to operate a pilot project.

Prevent pollution rather than control.
Past experience has shown that remedial actions to clean up polluted water bodies are generally much more expensive than applying measures to prevent pollution from occurring. Although wastewater treatment facilities have been installed and improved over the years in many parts of the country, water pollution remains a problem. In some situations, the introduction of improved wastewater treatment has only led to increased pollution from other media, such as wastewater sludge. The most logical approach is to prevent the production of wastes that require treatment. Thus, approaches to water pollution control that focus on wastewater minimisation, in-plant refinement of raw materials and production processes, recycling of waste products, etc., should be given priority over traditional end-of-pipe treatments. For water pollution originates from diffuse sources, such as agricultural use of fertilisers, which cannot be controlled by the approach mentioned above. Instead, the principle of "best environmental practice" should be applied to minimise non-point source pollution.

Apply the polluter-pays-principle: The polluter-pays-principle, where the costs of pollution prevention, control and reduction measures are borne by the polluter, is not a new concept but has not yet been fully implemented, despite the fact that it is widely recognized that the perception of water as a free commodity can no longer be maintained. The principle is an economic instrument that is aimed at affecting behavior, i.e. by encouraging and inducing behavior that puts less strain on the environment. Examples of attempts to apply this principle include financial charges on sewage generated by urban population, industrial waste-water discharges and special taxes on pesticides. The difficulty or reluctance encountered in implementing the polluter-pays-principle is probably due to its social and economic implications. Full application of the principle would upset existing subsidized programmes (implemented for social reasons) for supply of water and removal of wastewater in India. Nevertheless, even if the full implementation of the polluter-pays-principle is not feasible at present, it should be maintained as the ultimate goal.

Balance economic and regulatory instruments: Until now, regulatory instruments have been heavily relied upon. Economic instruments, typically in the form of wastewater discharge fees and fines, have been introduced to a lesser extent. Compared with economic instruments, the advantages of the regulatory approach to water pollution control is that it offers a reasonable degree of predictability about the reduction of pollution, i.e. it offers control to authorities over what environmental goals can be achieved and when they can be achieved. A major disadvantage of the regulatory approach is its economic inefficiency. Economic instruments have the advantages of providing incentives to polluters to modify their behaviour in support of pollution control and of providing revenue to finance pollution control activities. In addition, they are much better suited to combating nonpoint sources of pollution. The setting of prices and charges are crucial to the success of economic instruments. If charges are too low, polluters may opt to pollute and to pay, whereas if charges are too high they may inhibit economic development. Against this background it seems appropriate, therefore, to apply a mixture of regulatory and economic instruments for controlling water pollution. In our country financial resources and institutional capacity are very limited, the most important criteria for balancing economic and regulatory instruments should be cost-effectiveness and administrative feasibility.

Establish mechanisms for cross-sectoral integration: since water quality management is related to many sectors, their involvement is very crucial in implementing various policies and regulations. The most important ones are: Ministry of Water Resources, Central Water Commission, Central Ground Water Board, State ground Water departments, State Irrigation/Water Resources Departments, Rajiv Gandhi Drinking Water Mission, State Public Health Departments, Water Supply Authorities, Ministry of Industries, Ministry of Power, and Ministry of Urban Development, Ministry of Agriculture. In order to ensure the co-ordination of water pollution control efforts within water-related sectors, a formal mechanisms and means of co-operation and information exchange need to be established. Such mechanisms should:

• Allow decision makers from different sectors to influence water pollution policy.
• Urge them to put forward ideas and plans from their own sector with impacts on water quality.
• Allow them to comment on ideas and plans put forward by other sectors. For example, a permanent committee with representatives from the involved sectors could be established. The functions and responsibilities of the cross-sectoral body would typically include at least the following:
• Co-ordination of policy formulation on water pollution control.
• Setting of national water quality criteria and standards, and their supporting regulations.
• Review and co-ordination of development plans that affect water quality.
• Resolution of conflicts between different states and government bodies regarding water pollution issues that cannot be resolved at a lower level.

Encourage participatory approach with involvement of all relevant stakeholders: The participatory approach involves raising awareness of the importance of water pollution control among policy-makers and the general public. Decisions should be taken with full public consultation and with the involvement of groups affected by the planning and implementation of water pollution control activities. This means, for example, that the public should be kept continuously informed, be given opportunities to express their views, knowledge and priorities, and it should be apparent that their views have been taken into account. Various methods exist to implement public participation, such as interviews, public information sessions and hearings, expert panel hearings and site visits. The most appropriate method for each situation should take account of local social, political, historical, cultural and other factors. Public participation may take time but it increases public support for the final decision or result and, ideally, contributes to the convergence of the views of the public, governmental authorities and industry on environmental priorities and on water pollution control measures.

Give open access to information on water pollution: This principle is directly related to the principle of involvement of the general public in the monitoring, decision-making process, because a precondition for participation is free access to information held by public authorities. Open access to information helps to stimulate understanding, discussions and suggestions for solutions of water quality problems.

Promote interstate co-operation on water pollution control: Trans-boundary water pollution, typically encountered in large rivers, requires interstate co-operation and co-ordination of efforts in order to be effective. Lack of recognition of this fact may lead to wasteful investments in pollution load reductions in one state if, due to lack of cooperation, measures are introduced upstream (Delhi-Haryana case) that have counteractive effects. Permanent interstate bodies with representatives from riparian states can be established, with the objective of strengthening interstate co-operation on the pollution control of the shared water resources.

Economic Instrument for Pollution Control: Besides the 'command and control' regulatory mechanism the government has also introduced major economic incentives for pollution abatement in India, not as alternative to regulation but only as a supplementary measure. The Water Cess Act was introduced in 1977, empowering the state pollution control boards to levy a cess on local authorities supplying water to consumers and on consumption of water for certain specified activities. The Act also provides for a rebate on the cess payable if the person or local authority concerned installs a plant to treat sewage or trade effluent. Besides the Water Cess Act, efforts have to be made to introduce and implement the Zero discharge concepts, which would enhance recycle and reuse of effluent discharge.

Waste minimization and clean technologies

It may be noted that by recycling techniques the waste concentrations may increase, however the total load remain the same. The concentration of waste strength would help the economical conversion of spent wash to biofertilizer. Waste strength reduction can be achieved by adopting in plant control measures such as reduction of spillages of wastes, elimination of process failures, use of proper equipment for handling and dry cleaning techniques etc. This is often termed as clean technologies; it does not add to the cost of production, in fact industry gains from it.

Innovation in pollution prevention/waste minimization efforts on the part of the industries needs to be sternly promoted. Pollution prevention/ waste minimization, in our country at least, is done only for product quality improvement, energy saving or other economic reasons and any reduction in pollution is only incidental.

All organic wastes are best source of energy. A number of anaerobic technologies are now available for treatment of organic industrial effluents. Spent wash, black liquor (pulp mill), dairy effluents, sugar factory effluents and press mud etc. are some of the organic wastes tried for energy recovery. The energy recovery will incidentally solve the air pollution problem, as biogas is a cleaner fuel compared to baggasse, rice husk or coal. It is essential to introduce energy audit in all the industries so hat cost-benefit ratio can be established in each case.

Bio-fertilizers are now prepared from organic rich wastes by admixing filler materials. Spent wash is converted to manure by addition of press mud, bagasse cillo, agricultural residues etc. In this technology the entire liquor effluent is converted into solid mass and it can be termed as "Zero-discharge" technology.