URBAN WATER QUALITY MONITORING PROTOCOL

Housing and Urban Development Department

Government of Odisha, Bhubaneswar

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1. Introduction

1.1 Importance of water quality and monitoring

Provision of safe drinking water is essential to promote public health and ensure prevention and control of water borne diseases. As per reports of the World Health Organisation (WHO), water-borne diseases such as diarrhoea are the leading cause of illness and death especially in under developed and developing countries. Despite an increased access to clean drinking water in urban areas of India in the past few decades, the quality of water supplied has remained an area of concern. Estimates suggesting that over 3.7 crore Indians are affected by water related diseases annually, an improvement in drinking water quality, is expected to result in enhanced public health outcomes.

Quality of drinking water is a serious concern in urban areas of India, with cities facing problems of water contamination time to time. Contamination of water source is mainly due to naturally occurring minerals (As, Fe, Cr), land use practices (pesticides, fertilizers), manufacturing processes with toxic wastes disposed from industries, depletion and degradation of ground water resources, disposal of untreated waste water (microbes), storm water runoff (oil, grease, etc.) and inadequate maintenance of water-supply distribution pipelines. According to the National Urban Sanitation Policy (NUSP) of Ministry of Urban Development (MoUD), Government of India (GoI), inadequate discharge of untreated domestic /municipal wastewater has resulted in contamination of 75 percent of surface water sources across India leading to spread of water-borne diseases in urban areas. Public water supply service agencies are required to treat the water to make it safe for human consumption. While the addition of chemicals to make water safe for human consumption is widely practised and accepted, any residual amount of these chemicals, their contaminants or by-products also could pose a serious health risk, if not monitored adequately.

Given the challenges of water contamination and inadequate maintenance of water supply systems, the MoUD, GoI insists on carrying out routine water quality management and surveillance practices to ensure safe water supply to consumers. Provision of safe drinking water has also been a thrust area in Government of India's 12thFive Year Plan (2012-2017). The Central Public Health and Environmental Engineering Organization (CPHEEO), a nodal agency of MoUD, has developed a numerous manuals in this regard, which guides Public Health and Engineering Departments, Urban Local Bodies (ULBs) and other water supply agencies on operations and maintenance of water supply system including management of water sources, water treatment, safe transmission of water and water quality surveillance.

Odisha Urban Water Policy, 2013 has given priority to set up efficient and effective surveillance system for monitoring water quality in urban areas of Odisha. Water quality management and surveillance practices ensure safe water supply to consumers.

Surveillance of drinking water quality is defined as the continuous and vigilant public health assessment and overview of the safety and acceptability of drinking water supplies (WHO, 1976). It involves laboratory and field testing of water samples collected from various points in the water supply system, including the source, water treatment plants, service reservoirs distribution systems and at the consumer end which are representative of the condition of water at the point and time of collection.

Accordingly, a standard set of guidelines on water quality monitoring are being formulated for the benefit of water supply service agencies with Odisha and the concerned officials.

1.2 Current water quality monitoring system in Urban Odisha

The Public Health Engineering Organisation (PHEO)[1]of Odisha, through its division/sub-division offices spread across the state, is the service provider for treated water supply in the Urban Local Bodies

[1]PHEO is the state level directorate functioning under Housing & Urban Development Department of Government of Odisha

(ULBs) of Odisha, classified as municipal corporations, municipalities and notified area councils. At present, the routine monitoring of drinking water quality in Odisha is a joint/ independent responsibility of the PHEO and Rural Water Supply and Sanitation (RWS&S).

A certain level of water quality testing is performed within the drinking water systems operated by PHEO. The residual chlorine testing is conducted on-site and the water samples are sent to the existing government/ accredited laboratories for physical and chemical tests at Cuttack, Sambalpur and Rourkela and for bacteriological testing at Bhubaneswar. PHEO has further proposed the establishment of new state-of-the-art water quality testing laboratories within the circle offices located at five municipal corporations, i.e., Bhubaneswar, Cuttack, Berhampur, Sambalpur and Rourkela in addition to existing laboratories. All other sub-divisions rely on district or other accredited laboratories for water quality testing.

Evidences suggest PHEO division/sub-divisions within the jurisdiction of larger municipal corporations (i.e., Bhubaneswar and Cuttack) have a somewhat established procedure for drinking water quality monitoring and surveillance. Other divisions/ sub-divisions across smaller municipal corporations and municipalities of Odisha although conduct water testing from time to time but do not have a set regime for routine monitoring and surveillance, documentation and sharing procedures.

The data on water quality under the Service Level Benchmarking (SLB) initiative for 2013-14 indicates that more than 80 % of water samples tested by ULBs conformed to the specified parameters of drinking water quality. The data reliability for water quality however seems to fall under category-D implying a lack of established regimen for water quality monitoring and/or inadequate data recording and management practices. Though the CPHEEO recommends conducting residual chlorine, physical, chemical and biological tests at a minimum, less than fifty percent PHEO laboratories carry out all of these required tests. The PHEO proposes to undertake special monitoring programs to assess the effectiveness of treatment and mitigation measures, new parameters, and other tap water quality related issues.

2. Objective of this Protocol

Understanding the status and trends of water from surface and groundwater sources and conditions that affect them are essential to the success of various initiatives taken up by PHEO. Having a standard framework that helps the technical staff of the organisation determine these trends and conditions in a consistent and verifiable way is essential. The use of a standard water quality monitoring protocol, described in this document, provides them with such a framework.

The key objectives of this protocol are to provide an integrated manual of sampling protocols for water quality monitoring in Odisha in order to increase consistency across the state and to describe various elements of laboratory management practices to ensure that the data generated is comparable and scientifically correct and in a form that can then be used to result in interventions to improve water quality. The data collected through periodic monitoring can be useful to undertake requisite corrective measures in existing water supply distribution systems as well as plan the preventive actions for any proposed extension of distribution systems.

Therefore, the purpose of this document is to outline the standard procedures for various components of drinking water quality monitoring activities undertaken by the PHEO and shall remain an integral component of the in-house Quality Assurance/Quality Control (QA/QC) program. This document is expected to

- Serve as a reference guide for staff involved in drinking water quality monitoring
- Ensure a consistent approach for drinking water quality monitoring; and
- Provide standard operating procedures for water quality monitoring activities.

The standard procedures highlighted in the document complement those provided in the manuals published by WHO, CPHEEO, BIS, etc. This manual is intended to be dynamic in nature and will be modified as the program and activities change.

2.1 How to use this protocol

th The protocol will be helpful at the grass-root level for the personnel working in various drinking water testing laboratories. In addition, it will provide guidance to the persons at different managerial levels to tackle water quality-affected habitations by adopting water safety approach.

2.2 Scope and limitation of the protocol

The PHEO monitoring program has evolved from a simple daily sampling of source water from selected sources, to design and planning of a multifaceted and integrated program aimed at documenting all aspects of water quality from water supply source to the consumer's tap. Occasionally, in responses to rare occurrences of incidents, circumstances may dictate any other special interventions to be undertaken for drinking water quality monitoring in the Odisha. Such non-routine activities are beyond the scope of this manual.

3. Definitions

Presented below are the definitions of various terms used in the protocol.

1. **Acidity —** Acidity is a representation of carbon dioxide or carbonic acids which causes corrosion in public water supply systems. Acidity of water may be caused by the presence of un-combined carbon dioxide, mineral acids and salts of strong acids and weak bases. It is expressed as mg/L in terms of calcium carbonate.
2. **Alkalinity —** the alkalinity of water is a measure of its capacity to neutralize acids. It is expressed as mg/L in terms of calcium carbonate. Alkalinity is an important parameter in evaluating the optimum coagulant dosage.
3. **BOD -** Biochemical oxygen demand (BOD) is the amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic material present in a given water sample at certain temperature over a specific time period. The BOD value is most commonly expressed in milligrams of oxygen consumed per litre of sample during 5 days of incubation at 20 °C and is often used as a robust surrogate of the degree of organic pollution of water.
4. **Chlorides —** Chloride ion may be present in combination with one or more of the cations of calcium, magnesium, iron and sodium. Excessive chloride in water indicates presence of septic tank effluents, animal feeds, industrial effluents, irrigation drainage, and seawater intrusion in coastal areas.
5. **Chlorine:** Residual chlorine remaining in the water at the end of a specified period.
6. **Chlorine Demand:** the difference between the amounts of chlorine added to water and amount of residual chlorine remaining in the water at the end of a specified period.
7. **COD -**Chemical oxygen demand (COD) test is commonly used to indirectly measure the amount of organic compounds in water. Most applications of COD determine the amount of organic pollutants found in surface water (e.g. lakes and rivers) or wastewater, making COD a useful measure of water quality. It is expressed in milligrams per liter (mg/L) also referred to as ppm (parts per million), which indicates the mass of oxygen consumed per liter of solution.
8. **Coli form Bacteria:** group of bacteria predominantly inhabiting the intestine of human beings and animals, but also occasionally found elsewhere. Used to indicate presence of faecal pollution. Enteric having its normal habitat in the intestinal tract of human beings or animals.

9. **Colour —** Safe drinking water should be colourless. Dissolved organic matter from decaying vegetation or other inorganic materials can impart colour to the water.
10. **Contamination:** is the introduction into water of toxic materials, bacteria or other deleterious agents that make the water hazardous and therefore unfit for human use.
11. **Drinking Water —** Drinking water is water intended for human consumption for drinking and cooking purposes from any source. It includes water (treated or untreated) supplied by any means for human consumption
12. **Fluorides —** Fluoride is a naturally occurring compound derived from fluorine. It is found in many rocks and minerals in the soil and enters drinking water as water passes through these soils. Fluoride has been shown to prevent tooth decay, but too much fluoride can cause teeth discoloration.
13. **GPS–**Global Positioning System shall be used to determine the water quality sampling locations
14. **MPN –**Most Probable Number is the unit to determine the presence of coliform bacteria in water sample.
15. **Organoleptic properties:** Aspects of substances as experienced by the senses, including taste, sight, smell, and touch.
16. **Palatable Water** that is appealing to the sense of taste, sight and smell. Palatable water need not always be potable.
17. **Parts per million (ppm)** or milligrams per litre (mg/l) these terms are used to express the concentrations of dissolved or suspended matter in water. The parts per million (ppm) is a weight to weight or volume to volume relationship. Except in highly mineralized water, this quantity would be same as milligram per litre. This is preferable, since it indicates how it is determined in the laboratory.
18. **Pathogens** disease-producing organisms. Bacteria a group of universally distributed, essentially unicellular microorganisms lacking chlorophyll.
19. **pH** of water an expression of the Hydrogen ion concentration. Alkaline water is with pH of above 7 and acidic water has pH of below 7; whereas water with pH 7 is neutral. pH value denotes the acidic or alkaline condition of water which is expressed on a scale ranging from 0 to 14, which is the common logarithm The recommended pH range for treated drinking water, is 6.5 to 8.5
20. **Pollution** is the introduction into water of substance in sufficient quantity to affect the original quality of water, make it objectionable to sight, taste, smell or make it less useful.
21. **Potable --** Water that is satisfactory for drinking purposes from the standpoint of its chemical, physical and biological characteristics.
22. **ppb –** Parts per billion is the unit to measure the concentration of chemical concentrations similar to ‘parts per million’ or ‘ppm’ discussed above.
23. **STP**–Sewage Treatment Plant
24. **Turbidity —** Turbidity is the cloudiness or haziness caused by individual particles which makes the water appear non-transparent. If a large amount of suspended solids are present in water, it will appear turbid in appearance indicating presence of impurities.
25. **Taste and Odour —** Most organic and some inorganic chemicals, originating from municipal or industrial wastes, contribute taste and odour to the water which may make it unfit for human consumption. Taste and odour can be expressed in terms of odour intensity or threshold values.
26. **TDS —** TDS is a measure of the combined content of all inorganic and organic substances contained in water in molecular, ionized or micro-granular (colloidal sol) suspended form.

27. **Temperature —** the ideal temperature of water for drinking purposes is 5 to 12 °C - above 25 °C, water is not recommended for drinking. The increase in temperature decreases palatability, because at elevated temperatures carbon dioxide and some other volatile gases are expelled.
28. **Toxic**- is harmful, destructive or deadly poisonous. Physiological effect having effect on the normal functions of the body.
29. **ULB**–Urban Local Body
30. **Virus -** the smallest form capable of producing infection and diseases in human beings
31. **WTP -** Water Treatment Plant

4. Water quality monitoring and surveillance

4.1 Monitoring of water quality

Monitoring of water quality by the water supply agency involves laboratory and field testing of water samples collected from various points in the water supply system, including the source, water purification plants, service reservoirs distribution systems and consumer end, representative of the condition of water at the point and time of collection. Continuous water quality monitoring involves good operating practices and preventive maintenance, as well as the regular routine testing, and monitoring of water quality to ensure compliance with standards.

4.2 Surveillance of water quality

Surveillance is an investigative activity undertaken by engaging a separate agency, in the absence of which the same shall be undertaken by a dedicated quality control wing of water supply agency to identify and evaluate factors posing a health risk to drinking water. Surveillance requires a systematic program of surveys that combine water analysis and sanitary inspection of institutional and community aspects, and reporting system.

Sanitary inspection of water supply system should cover the whole system including water sources, rising mains, treatment plants, storage reservoirs, and distribution systems; to identify most common risks and shortcomings in the water supply. Moreover, surveillance is concerned with all sources of water used for domestic purpose by the population, whether supplied by a water supply agency or collected from other individual sources. So it is important to inspect and analyse all sources of water used and intend to be used for human consumption.

An external agency undertaking surveillance for a specific purpose shall communicate to the water supply agency and pinpoint the risk areas and give advice for remedial action. It should also maintain good communication and cooperation with water supply agency for detection of risk areas and remedial action for betterment of water supply. The table below gives functions and responsibilities of agencies for water quality monitoring and surveillance.

Agency	Functions	Responsibilities
Surveillance Agency 1. Department of Health 2. State PHEO/Urban Development 3. Local Health Authority, CMO/Health Officer 4. State Pollution Control Board	Surveillance of drinking water quality	• To ensure that the drinking water is free from health hazards. • To find out what is wrong. • Assist in setting things right for both rural and urban systems.
Water Supplying Agency 1. State PHEO/Water Boards 2. Urban Local Bodies/Authority 3. Autonomous Agencies	Supply of potable water	To provide water in sufficient quantity and potable quality to the population at sufficient pressure.

Pollution Control Board, Central/State	Controlling pollution at water source	To protect the raw water sources from being unduly polluted at Country/State level.

4.3 Designing Water Quality Monitoring and Surveillance Program

Monitoring and surveillance activities differ from region to region, between urban and rural communities and according to the types of water supply. They should be adapted to local conditions, availability of local finances, infrastructure and knowledge. Water supply provider and surveillance agencies, depending on resources[2] available with them, shall develop the program for monitoring and surveillance of drinking water quality.

The PHEO shall design a water quality monitoring and surveillance program, with a goal of providing every urban household with adequate safe water for drinking, cooking and other domestic basic needs on a sustainable basis. This basic need should meet minimum water quality standards and be readily and conveniently accessible at all time and in all situations.

Water supply for drinking and cooking shall be as per Bureau of Indian Standard (BIS) IS: 10500 and for other household needs, the water should be of acceptable standard. Water is considered as safe if it is free from physical and biological contamination and within permissible limit of chemical contamination. The portability and reliability of drinking water quality standard both at the production (water treatment plant) as well as at the consumption point (household level) shall be done by the water quality testing and sanitary inspection.

The main objectives of the monitoring and surveillance program shall be as follows:

- Decentralized monitoring and surveillance of all drinking water sources in the state.
- Institutionalization of community participation for water quality monitoring and surveillance.
- Generation of awareness within the urban areas about the water quality issues and problems related to water borne diseases.
- Capacity building to use the field test kits and take up full O&M responsibility for water quality monitoring of all drinking water sources.

Surveillance program can be phased out in three distinct phases – initial, intermediate and advanced.

Initial Phase	Intermediate Phase	Advanced Phase
• Identify agencies and develop collaboration. • Finalize institutional requirements. • Prepare inventories of water supply system. • Preliminary training for staff.	• Establish and expand systematic routine surveillance. • Expand analytical capability. • Train staff. • Use draft standard methods for analysis and field works.	• Establish routine surveillance for all health parameters at defined intervals. • Use guidelines as given in Manual on Water Supply and Treatment. • Give advance training to staff.

[2]Monitoring and surveillance programs require laboratory network, offices, transport, financial support and adequate staffing.

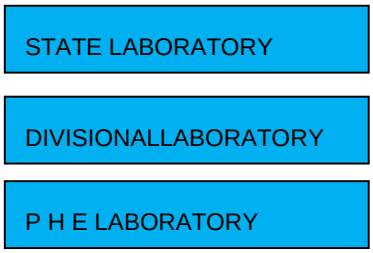
• Assess and identify priority areas for sample collections. • Develop methodologies for water quality analysis. • Commence routine surveillance in priority areas. • Limit water analysis to critical parameters only. • Establish reporting, filling and communication systems. • Identify community roles and promote participation.	• Establish data based archive. • Identify common problems and improve activities accordingly. • Use legal enforcement where possible. • Involve community	• Use full network of local, regional and state laboratories. • Improve water services on the basis of local priorities, hygiene awareness and • Enforcement of standards. • Involve communities. • Disseminate data at local, regional and state level

4.4 Community Based Monitoring and Surveillance

Community participation is an essential component of the monitoring and surveillance framework. As the primary beneficiaries community can play an important role in surveillance activity. They are the people who may first notice the problems in water supply and report it to concern agency or take remedial action if possible. Establishing a genuine partnership with the community creates a climate of trust and understanding, which generates interest and enthusiasm. It also provides a good foundation for other educational activities such as promotion of good hygiene practices. The community based monitoring and surveillance can be carried out in two ways through, (a) Selection of community volunteers, including women, to undertake surveillance activities after training and (b) Providing encouragement to local worker to carry out certain jobs pertaining to surveillance.

5. Institutional Framework

Water quality laboratories are the main backbone of water quality monitoring and surveillance program. Well-located and well-equipped analytical laboratories with competent staff are very essential to evaluate the efficiency of water utility services in terms of water quality. Provision of safe drinking water therefore warrants a strong laboratory network within the state for water quality assessment. The network of such water quality assessment laboratories may have a structure based on a state laboratory, a certain number of division based laboratories, and a series of basic laboratories at the Water Treatment Plant or Waste Water Treatment Plant level.



Laboratory Network for Water Quality Assessment

The state laboratory should be accredited to National Accreditation Board for Water Testing Laboratories (NABL) and International Organisation for Standardisation (ISO). The laboratory should be well-equipped to deal with the parameters identified in the Bureau of Indian Standards on quality standards for drinking water. It is required to be responsible for performing external control on the quality of the analysis performed by the smaller laboratories.

The bigger divisional laboratories should be capable of carrying out a moderate series of physical, chemical and microbiological analyses, which must be subject to quality assurance programmes to guarantee their quality. In addition they should have the capacity to offer support services to the basic laboratories or to the staff carrying out tests using portable equipment.

The proposed three-tier laboratory network comprises of state, divisional and basic laboratories at the site as per the necessity of ULB/WTP/ STP. Criteria for location and number of laboratories (especially PHE laboratories) shall depend on various aspects like:

- Number of water supply schemes in the basin;
- Population served;
- Concentration of industries;
- Logistics (distance); and
- Financial implications.

The envisaged administrative control within the proposed hierarchy of 3-tier laboratory network for water quality testing in Odisha is illustrated in the figure below.

However, depending on the local context and the need, merger of lower level laboratories with higher category laboratories in the same location shall be explored to reduce the cost of laboratory infrastructure and man-power requirements. At the location of state headquarters, the state level laboratory may be merged with upgraded division level laboratory. Similarly, at the division headquarters, the division level laboratory may be merged with basic (PHE) laboratory at WTP. The mobile units will always be part of the State laboratory.

5.1 Functions of a Water Quality Testing Laboratories

Within the proposed hierarchy, it may be noted that the basic WTP level laboratory is meant for control and optimisation of treatment process. All the additional parameters in case of a plant of greater capacity shall be taken up by divisional laboratory. The envisaged functions of quality testing laboratories across proposed 3-tier structure in Odisha are given below:

#	Laboratory level	Function
1	Basic	Process control and optimisation
2	Divisional	Surveillance of distribution system Analysis of bore well/Source
3	Mobile	Disaster management Special assigned task
4	State	Analysis of bore well/Source R & D ,Training, Quality control

In general, the key function of a water-testing laboratory is to determine the water quality for drinking and domestic use. Undertaking this function involves the activities viz., (a) collection of water samples from field with suitable preservation, (b) sanitary surveillance, (c) water sample storage with suitable preservation, and (d) requisite data analysis. The other functions would include:

- Delineating the potential areas of water contamination (hotspots);
- Determining the risk of pollution from various sources like agricultural practices (pesticides and fertilisers), industrial discharges, municipal sewage disposal and disposal of solid wastes;
- Communicating the results to concerned officials for corrective actions;
- Follow-up water quality monitoring after implementation of corrective actions particularly if source is bacteriologically contaminated;
- Identifying sampling stations and frequency; and
- Providing reference point to monitor improvement or deterioration in water quality.

The accreditation process and details of infrastructure and staffing requirements for different categories of water quality assessment laboratories are detailed out in Section-7 of this document.

6. Water Quality Analysis Requirements

The main purpose of water quality testing is to assess the quality and classify the raw water to be treated; to determine the need and extent of treatment; to check that water has been properly prepared for each phase of treatment process; to ensure that each phase of treatment proceeds according to plan and to examine the finished water to ascertain that it conforms to the standards.

The other objectives served by regular testing program include (a) determination of trends in drinking water quality over time, (b) provision of information to public health authorities for general public health protection purpose and (c) identification of sources of contamination.

6.1 Parameters to be monitored

The potential water contaminants, classified into chemical (organic), chemical (inorganic), microbiological, radiological contaminants, are listed in the Annexure-1 of this document and the

pathways for water contamination are listed in Annexure-3. Based on the need, the parameters for water quality assessment and monitoring are summarised as below:

- Physical parameters – temperature, turbidity (NTU), colour (PtCo), taste and odour, free residual chlorine, dissolved and suspended solids;
- Chemical parameters – acidity, alkalinity as calcium carbonate, pH, hardness (as CaCO3), calcium, chloramine, magnesium, iron, sulphates, sulphides (as H2S), phosphates, silica, fluorides, chlorides, mineral oil, nitrates (as NO3), nitrites (as NO2), phenolic compounds, sodium, potassium, total dissolved and suspended solids
    - Metals such as manganese, copper, zinc, aluminium, barium, boron, selenium, silver, cadmium, lead, mercury, nickel , arsenic, chromium;
- Bacteriological parameters– total coliform bacteria (MPN count), Escherichia coli (E.coli) thermo-tolerant coliform bacteria (MPN count),
- Micro biological parameters–faecal streptococci, algae, zooplanktons, flagellates, cryptosporidium, giardia, cercariae of schistosomiasis, embryos of dracunculus medinensis.
- Pesticides - alachlor, atrazine, aldrin/ dieldrin, alpha HCH, beta HCH, butachlor, chlorpyriphos, delta HCH,2,4- dichlorophenoxyacetic acid, DDT (o, p and p, p – isomers of DDT, DDE and DDD), endosulfan (alpha, beta, and sulphate) ethion, gamma — HCH (lindane), isoproturon, malathion, methyl parathion, monocrotophos, phorate
- Toxicity - cyanide, polychlorinated biphenyls, poly nuclear aromatic hydrocarbons, tri-halo methanes, alpha emitters Bq/l, max beta emitters Bq/l,

The basic minimum parameters that need to be tested at each WTP for establishing credibility of the drinking water supply quality will include pH, turbidity, residual chlorine, alkalinity, iron, total coliforms and E-coli. The prescribed quality standards for drinking water as per CPHEEO Manual and Bureau of Indian Standards are presented in Annexure-4.

Depending on the capacity of Water Treatment Plant (WTP) and available laboratory equipment[3], the parameters required to be monitored at each basic laboratory at WTP level as per CPHEEO Manual[4]are given in Annexure-5, of this document. The functional capabilities of testing laboratories at state, divisional and basic laboratories may be summarised as below.

Table: Functional capabilities of the various laboratories

Sl. No.	Name of the test	Laboratory levels		
		Basic	Divisional	State
1	Colour, Odour, pH, Turbidity, Conductivity, Residual chlorine	√	√	√
2	Alkalinity, Hardness	×	√	√
3	Iron ,Chloride, Fluoride, DBP	×	√	√
4	Total solids, Suspended solids	×	√	√
5	Jar Test	√	√	√
6	Test of treatment aids like bleaching powder, alum, lime, poly aluminium chloride, filter media sand, gravel	×	×	√
7	Nitrogen (ammonia) Nitrites Nitrates	×	√	√
8	Phosphates (ortho, meta, poly)	×	√	√
9	Sodium, Potassium, Lithium, Boron	×	√	√

[3]Laboratory equipment is discussed in the section 7.1.3 of this document

[4]The Manual on Water Supply and Treatment, CPHEEO, 1999

10	Metal, viz., Arsenic, Aluminium, Heavy metals	×	√	√
11	Chlorine demand	×	√	√
12	Bacteriological analysis	√	√	√
13	Virological analysis, Biological analysis	×	×	√
14	Waste water analysis viz., BOD, COD, TOC,	×	√	√
15	Additional parameters, oil and grease, pesticides,	×	×	√
16	Toxicity, Alpha/beta count	×	×	√

Within the proposed hierarchy of water testing laboratories in Odisha, the state level laboratory shall focus on analysis of specific parameters enumerated by BIS where-as the divisional laboratories shall limit to CPHEEO requirements. Laboratories at each Public Health (PH) Division and WTP level shall take up routine area specific approach. In addition to the capability of undertaking quality tests for above parameters, the laboratories shall also have the following functional capabilities.

Sl. No	Function	Laboratory level		
		Basic	Divisional	State
1	Surveillance of distribution system	×	√	×
2	Database management	×	×	√
3	Research & Development	×	×	√

6.2 Protocol for Sampling

Samples shall be collected from locations that are representative of all the water source(s), treatment plant(s), storage facilities, intermediary points within the distribution network, and points at which water is delivered to the consumer, and points of end-use. Factors such as population density and accessibility shall be considered when choosing sampling locations. A map or sketch of the water distribution system shall be used to locate general sampling locations that give samples representative of various characteristics of the distribution system. Depending on the local context and available resources, a sampling plan for water quality monitoring shall be prepared and implemented at each laboratory. It is important that a written sampling protocol with specific sampling instructions be made available to and used by laboratory staff and other competent sample collectors.

Accurate analysis of water quality sample depends on the factors such as, methods of sample collection, methods of storage and protocol for microbial and chemical analysis, data analysis and interpretation. Inadequate care in undertaking any of these steps leads to inaccurate results and the entire operation will result in wastage of time, energy and resources. The methods of sampling for physical and chemical examinations as well as microbiological examinations of water are prescribed by Bureau of Indian Standards (BIS). The BIS code IS: 3025 (Part-1)-1987 and IS: 1622-1981, may be referred to for detailed information.

The laboratory should reject any sample which does not meet the criteria and ask for a resample. If re-sampling is not possible, the inadmissibility of these sample data need to be clearly communicated to all end data users. Following general precautions may be taken while collecting water samples for testing.

- Collect the sample that conforms to the requirement of the sampling plan and handle it carefully so that the sample does not deteriorate or get contaminated during its transport to the laboratory.
- Before filling the container, rinse it two or three times with the water being collected.

- Representative samples of some sources can only be obtained by making composites of samples collected over a period of time or at a number of different sampling points.
- While collecting a sample from the distribution system, flush lines adequately, taking into consideration the diameter and length of the pipe to be flushed and the velocity of flow.
- Collect samples from tube-wells only after sufficient pumping (purging) to ensure that the sample represents the ground water source.
- When samples are to be collected from a river or stream, analytical results may vary with depth, flow, distance from the banks. In surface water bodies, water samples should preferably be collected at 0.2 times the depth of the water body from the top.
- Make detailed record of every sample collected (with unique code and Global Positioning System coordinates). Identify each container and record information like date, time and exact location and condition.
- Samples shall be kept in a refrigerator or cooler with an ice-pack to maintain a temperature of 4 degree Celsius until delivered to laboratory (Samples should not be frozen). Samples shall be transported to laboratory as soon as possible or definitely within 24 hours of collection. Check ahead with laboratory about sample acceptance to ensure meeting the 24 hour criteria.

When collecting samples at a water source, it is important to collect Global Positioning System (GPS) coordinates and take pictures of (a) intake and surrounding area, (b) dam or water control structure, and (c) pump house or other structures of interest. State may undertake one time survey for recording GPS coordinates of drinking water sources by a suitable agency.

6.3 Quantity of Sample to be collected

Samples for chemical and bacteriological analysis should be collected separately as the method of sampling and preservation is completely different from each other. The interval between collection and analysis of the sample should be shortest possible.

- Quantity of sample for general analysis: 2 litres (non-acidified).
- Quantity of sample for bacteriological analysis: 250 ml in sterilized bottles.
- Quantity of sample for metals analysis: 1000 ml acidified sample for metal analysis.

6.4 Frequency of testing

The laboratories shall mandatorily carry out analysis of at least 13 basic water quality parameters viz., pH, Total Dissolved Solids, Turbidity, Chloride, Total Alkalinity, Total hardness, Sulphate, Iron, Arsenic, Fluoride, Nitrate, Total coliforms and Thermo-tolerant coliform or E-Coli.

State level laboratories shall be utilized for analysis of specific parameters like metals, pesticides, radioactive substances, bacteriological investigation, etc., along with general parameters. To establish the baseline, state level laboratory shall monitor the prescribed drinking water quality parameters at least once in a year. State laboratories may monitor Dissolved Oxygen (DO), Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) in surface water if eutrophication is observed/ reported. These parameters may also be of importance at the downstream of industrial areas/discharge of treated/partially treated/untreated sewage from urban local bodies. Thereafter, depending upon the occurrence of specific parameters in drinking water sources and their local relevance, number of the parameters or frequency of analysis for some parameters may be reduced as deemed appropriate by Government of Odisha.

The divisional and PH laboratories shall carry out testing and analysis of all the prescribed general water quality parameters at least once in pre-monsoon and post-monsoon season to establish a baseline. However, in case of detection of any pollutants, the parameters would need to be analysed

on routine basis. Suggested minimum sampling frequency (prescribed by CPHEEO manual) for water quality monitoring and water quality surveillance is given in tables below.

Table: Suggested Minimum Sampling Frequency for Water Quality Control Monitoring

S. No.	Size and Source	Frequency	Parameters							Remarks
			Residual Chlorine	Physical	Chemical	Bacteriological	Biological	Metals & Pesticides	As, r+6, Fe & Mn, Fluoride	
1	< 50,000 Population	i. Daily	√							From source & distribution system
	a. Ground Water (Tube Well, Sanitary Well, Bore Well)	ii. Quarterly		√	√	√			√	
	b. Ground Water(Hand Pump)	Twice a year		√	√	√			√	In summer & rainy season
2	>50,000 up to 1,00,000 a.From dist. System	i. Daily	√							
	b. Ground Water(Tube Well, Sanitary Well, Bore Well)	ii. Monthly				√				
		iii. Quarterly		√	√				√	
	c. Hand pump	Twice a year		√	√	√			√	In summer & rainy season
3.	>1,00,000 Population a. Ground Water (Tube Well, Sanitary Well, Bore well	i. Daily	√							From source & distribution system
		ii. Monthly				√				
		iii. Quarterly		√	√				√	
		iv. Annually						√		
	b. Ground Water(Hand pump)	i. Twice a year		√	√	√			√	In summer & rainy season
		ii. Annually						√		
4.	Surface water a. Raw water, source and intake point	i. Daily		√	√					
		ii. Weekly				√				
		iii. Annually						√	√	
		iv. Occasional					√			(As & when required)
	b. Sedimentation tank after clarifier	i. Daily								Turbidity only
		ii. Weekly				√				
		iii. Occasional					√			(As & when required)
	c. Filtered water	i. Daily								Turbidity only
		ii. Weekly				√				
	d. Clear water storage reservoirs	i. Daily	√	√	√					
		ii. Weekly				√				
	e. Distribution system	i. Daily	√							
		ii. Weekly				√				
		iii. monthly		√	√					

Note: Refer to the Manual on Water Supply and Treatment, III Edition, Ministry of Urban Development, New Delhi, May 1999, Appendix 15.9, for minimum tests to be performed. Parameters and frequency are general in nature and in case of special situations; they can be altered according to the local conditions by the local authority

Table: Suggested Minimum Sampling Frequency for Water Quality Control Surveillance

S. No.	Size and Source	Frequency	Parameters							Remarks
			Residual Chlorine	Physical	Chemical	Bacteriological	Biological	Metals & Pesticides	As, Cr+6,Fe & Mn, Fluoride	
1	< 50,000 Population	i. Daily	√							From source & distribution system
	a. Ground Water (Tube well, Sanitary well, Bore well)	ii. Quarterly		√	√	√			√	
	b. Ground Water (Hand Pump)	Twice a year		√	√	√			√	In summer & rainy season
2	>50,000 up-to 1,00,000	i. Weekly	√							From source Population and distribution system

S. No.	Size and Source	Frequency	Parameters							Remarks
			Residual Chlorine	Physical	Chemical	Bacteriological	Biological	Metals & Pesticides	As, Cr+6,Fe & Mn, Fluoride	
	a. Ground Water (Tube well, Sanitary well, Bore well)	ii. Quarterly				√				
		iii. Twice a year		√	√				√	
	b. Ground Water (Hand Pump)	Annually		√	√	√			√	In summer & rainy season
3.	>1,00,000 Population	i. Daily								From source & distribution system
	a. Ground Water (Tube well, Sanitary well, Bore well	ii. Weekly	√							
		iii. Quarterly				√				
		iv. Annually						√		
	b. Ground Water (Hand Pump)	i. Twice a year		√	√	√			√	In summer & rainy season
		ii. Annually						√		
4.	Surface water	i. Fortnightly				√				
	a. Raw water, source and intake point	ii. Quarterly		√	√					
		iii. Annually						√	√	
		iv. Occasional					√			(As & when required)
	b. Filtered water	i. Monthly				√				Turbidity only
	c. Clear water storage reservoirs	ii. Fortnightly	√			√				
		iii. Monthly		√	√					(As & when required)
	e. Distribution system	i. weekly	√							
		ii. Monthly				√				
		Iii, quarterly		√	√					

Note: Refer to the CPHEEO Manual on Water Supply and Treatment, III Edition, Ministry of Urban Development, New Delhi, May 1999, Appendix 15.9, for minimum tests to be performed; and Annexure-9.6c (1) of CPHEEO operation & maintenance manual (2004)

The minimum number of samples to be collected from the distribution system shall be as prescribed in the table below:

Population Served	Maximum intervals between successive sampling	Minimum number of samples from entire distribution system
Up to 20,000	One month	One sample per 5000 of population per month
20000 – 50000	Two weeks	
50000 – 100000	Four days	
>100000	One day	One sample per 10000 of population per month

6.5 Methods of analysis

Uniform methods of analysis shall be adopted by the laboratories within the network that are providing data to a common data bank, to ensure comparison and joint use of data and avoid methodology as a variable. If same constituent was measured using different analytical procedures within a single laboratory, or in several laboratories, questions are raised as to which procedure is superior, and why the superior method was not used. Standard methods as prescribed in the BIS shall therefore be strictly followed. Chemicals and glassware are to be procured as per requirement.

6.5.1 Validation of Method

The laboratory shall evaluate all its methods to determine if they are adequate for their intended use. This is especially important when existing methods are applied to new matrices or analyses for which

the laboratory has no previous experience or when new methods are introduced into the laboratory. This evaluation shall address the issues of analytical sensitivity, bias and precision over the range of interest of the target analyses. The following sections describe the procedures that shall be used to evaluate these analytical performance criteria.

6.5.2 Evaluation of Daily Performance

Once valid precision and accuracy data are available on the method, systematic daily checks are necessary to insure that valid data are being generated. First of all, verification of the originally-constructed standard curve is mandatory. Daily control of analytical performance in the laboratory requires approximately 5-20 percent of the analyst's time. Considering the elapsed time and combined efforts of skilled personnel that are represented in a final laboratory result, this is a comparatively small price to pay for, not a ”number", but a valid value.

6.5.3 Validation of data

It is necessary to ensure the quality of data through checks for correctness of chemical analyses. The checking of correctness of analysis has been referred to in the 21st Edition of Standard Methods, APHA, 2005, viz., checks for ion balance; checks for validity of measured and calculated TDS and EC; etc. The algorithm developed on the principles specified in Part 1030E and implemented through a Microsoft Excel Workbook is presented. Laboratories need to be provided with validation software.

6.6 Analytical Quality Control

The basic objective of water quality testing and analysis at the laboratory is to produce accurate data describing the physical, chemical, biological and microbiological characteristics of water samples under study. The guidelines in this document when implemented shall be considered to contribute to the overall programme of quality assurance[5]. Analytical quality control refers to routine application of procedures for controlling the measurement process that need to be implemented at the level of each laboratory and is an essential component of quality assurance. The following checklist may be used to ensure analytical quality assurance in an existing laboratory set-up.

Checklist for Quality Assurance:

Do laboratory personnel have?	— Clearly defined responsibilities? — Qualifications? — Experience? — Training?
Is space:	— Adequate for the types and number of analyses being undertaken?
Is equipment:	— Adequate? — Regularly serviced and maintained? — Calibrated and used only by authorized personnel?
Are materials:	— Bought from a reliable supplier, who carries out quality control?
Are there proper facilities:	— For receipt, storage of samples, and systems for coding and identifying them?
Are data:	— Archived? — Retrievable?
Are methods:	— Validated? — Documented? — Monitored (i.e. the results subjected to analytical quality control)?
Is safety assured by?	— Adequate working and waste-disposal procedures? — Training of staff?

[5]Quality assurance is the total programme for assuring the reliability of analytical data.

	— Proper maintenance of equipment? — Proper supervision of staff?

6.6.1 Internal quality control

Internal quality control or statistical quality control is an important component of any laboratory quality control programme. Experience suggests that 10 to 20 percent of laboratory resources should be devoted to such work. Suitable approaches to internal quality control may be followed. For each variable:

1. Analyse five standard solutions at six different known concentrations covering the working range to develop a calibration curve or, when a calibration curve already exists, analyse two standard solutions at different known concentrations covering the working range to validate the existing calibration curve.
2. Analyse one method blank per set of 20 samples.
3. Analyse one field blank per set of samples.
4. Analyse one duplicate of a sample chosen at random from each set of up to 20 samples.
5. Analyse one specimen that has been spiked with a known amount of the variable as a recovery check. This specimen should have a matrix similar to those of the samples being processed.

6.6.2 Remedial action

If any of the quality control procedures indicates that a method is out of control or that a problem exists, corrective action must be taken. The main checks to make are standard solutions, reagents calculations and records, equipment and quality control materials. Please refer SOP 11 of Annexure 10.

6.6.3 External quality control

External quality control is best applied after incorporating internal quality control practices in the laboratory, and consists of periodic analysis of reference samples.

6.6.4 Calibration

Regular calibration and checking of instruments against reference standards is essential. For example, at the start of conductivity or pH analysis the meter should be checked against a known standard and re-calibrated if necessary.

6.6.5 Quality management

Quality management shall be institutionalised at the testing laboratories. An official may be designated to supervise the internal and external quality control measures and perform internal audits of laboratory activities from time to time.

6.7 Reporting

Each laboratory should maintain detailed field reports regarding inspections and water analysis of all water supplies available in the area. The analysis results for all samples tested in field or sent to the laboratory should be duly recorded and compiled by the sub-division/ division offices of PHEO on a regular basis. The forms for recording these test results, should not be complicated, but must be comprehensive and provide all necessary information such as location where sample was taken, data and time and the results of the test. The forms should preferably be in the local language for the ease of field staff. The laboratory carrying out the bacteriological and chemical tests should record the results obtained in a standardized form. The information should also be passed on to regional authorities to allow follow-up.

The most common record is an internal bench sheet, or **bound book**, for recording of all data in rough form. Basic field laboratories or installations doing repetitive analyses for many parameters through-out the day may use a **pre-printed form**. With loose-sheet multi-copy forms information can be forwarded daily, weekly, or on whatever schedule is necessary, while allowing retention of all data in the laboratory.

The consumers have the right to know about the quality of water being supplied to them. Therefore, the agencies responsible for monitoring should develop strategies to inform the public, about the health-related results obtained by them along with recommendations for action (e.g., boiling during severe faecal contamination, household water storage education etc.) through publicity.

6.8 Information management and record keeping

Records are the documents that provide objective proof that all work was carried out and reported according to approved procedures. The records must be sufficient to permit a qualified individual to reconstruct and understand all steps in the process that produced the final result .Maintaining accurate, up-to-date, and easily retrievable records of laboratory activities are essential for reducing future liability (e.g. fines for regulatory non-compliance, costly clean-up cost), facilitating inspections (internal and external) and responding to customer and other enquiries and information requests.

All laboratory records, reports and other supporting documentation should be safely stored as hardcopy or electronic records, held secure and in confidence for the client. The system should cover those records currently in use by the analyst (e.g., log books, sample receipt records, bench sheets, calibration and QC records), recently completed project records (e.g., work completed in the last six months) and archival records removed from daily access but in a readily retrievable location. Examples of the types of materials that constitute laboratory records include, (but are not limited to)

a) Equipment maintenance records

b) Instrument logbooks,

c) Instrument calibration data,

d) Calibration records,

e) Certificates of purity/composition for all standards and reference materials,

f) Standard operating procedures,

g) Standard preparation logbooks

h) Chain-of-custody forms

i) Raw analytical data, both electronic and handwritten

j) QC results, and final reports

The laboratory should maintain a record inventory for all records. This inventory must be reviewed before the records are placed in archival storage. This shall assure that the necessary records are identified and retained by the laboratory.

Laboratories are required to maintain easily accessible records for five years and store records of chemical analyses of samples for 10 years. Changes in office, mergers, or closures of laboratories do not eliminate these requirements. This includes all raw data, calculations, and quality control data.

These data files may be either hard copy, microfiche or electronic. Electronic data should always be backed up by protected tape or disk or hard copy.

6.9 Database management

The digital data for the entire state which is produced and reported by different laboratories; need to be archived in one of five common databases, as follows:

- Raw Water Quality Database (intake)
- Production well water Quality Database
- Tap Water Quality Database (distribution system)
- Water treatment plant Database(stages of treatment)

- Sewage treatment plant Database (stages of treatment)

7. Requirements for setting up laboratories

7.1 Infrastructure requirements for Laboratories

Laboratories must be set-up with an approach of achieving efficiency and effectiveness, measured in terms of prompt performance of the analysis, reporting of results, and ensuring reliability of the results. Quality of analytical information shall have significant bearing on identification and effectiveness of corrective steps to rectify defects in the supply system that have caused the deterioration of water quality. Laboratories should have requisite infrastructure and materials congruent with the level of surveillance or control planned for the country, region or locality. Laboratory infrastructure shall include the following:

1. Requisite floor space
2. Location and built environment
3. Equipment and instruments
4. Furniture
5. Reagents for physical and chemical analyses, and culture media for bacteriology
6. Laboratory glassware, miscellaneous materials and calibration standards

7.1.1 Requisite floor space

The size of a laboratory depends upon the type of analysis carried out in it. The laboratory space could be divided into various functional units, viz., physical, chemical, bacteriological, biological, preparation room, etc. These spaces typically include analytical area, balance room, instrument room, microbiology room, sample room for sample receipt and sample storage, conference room-cum-library, staff office, computer room, store room, maintenance room, record room (archives), key personnel, field monitoring equipment room, and waste storage area. In case of lesser number of parameters for analysis, certain functional units could be combined into a single and smaller laboratory. Suitable accommodation shall be provided by each PH division for housing the basic laboratory at WTP level or the divisional laboratories. The space/area requirement for setting up divisional laboratories is expected to be about 80 square metres of covered area. Similarly, a minimum covered area of 20 square metres is required for setting up basic laboratories at WTP level. The space requirements for various functional units of laboratory are given below:

Table: Space requirements for laboratories

Sl. No.	Space requirement for laboratory area(m^2)	State laboratory	Divisional laboratory	Basic laboratory
1	Analytical area, balance and instrument room	100		
2	Microbiology room	30		
3	Biology room	30		
4	Sample room for sample receipt& storage	40		
	Chemical and physical testing laboratory		50	
5	Conference room-cum library	50		
6	Staff office	40	20	
7	Computer room	20		
8	Store room (glassware, chemicals& allied material)	30	10	

9	Maintenance room	30		
10	Record room (achieves, key personnel)	40		
11	Field monitoring equipment room	40		
12	Waste storage room	40		
	Total space requirement in square metres	**500**	**80**	**20**

7.1.2 Location and built environment

Location of laboratory: In principle, analysis should be carried out in a laboratory as near as possible to the place from where the samples are obtained, in order to reduce to a minimum the risk of their being altered during transport, particularly the microbiological samples. In case of a new laboratory, the location should be such that adequate natural lighting and ventilation is available.

Walls of laboratory: The walls should be finished smooth in light colours and should have sufficient thickness and provision for built in cabinets. The working table should be placed along the walls.

Lighting: Sufficient lighting shall be ensured in all work rooms including passages in the laboratory. Laboratory area shall be provided with sufficient number of windows with transparent window glasses. North-south facing of windows shall be preferred for elimination of glare on work tables. Adequate provision of artificial lighting may be ensured to supplement natural light. Additional plug points shall be provided for extra lighting, where required.

Balance room: Digital mono-pan balance shall be placed on separate (anti-static) table or in a separate room.

Floor and Table top: Should be of acid proof materials

Laminar Flow: Micro-biological laboratory must have a laminar flow to provide a sterilized work space

Sink: Laboratory room must contain a sink for hand washing and glassware washing. Exposure to hazardous materials and/or pathogenic organisms can occur by hand-to-mouth transmission. It is extremely important that hands are washed prior to leaving the laboratory.

Media preparation and sterilization room: For bacteriological analysis, additional facilities for media preparation, centrifuging, sterilization by autoclaving etc. are essential and separate room for accommodating these facilities needs to be provided. This room shall be attached to the laboratory and located within easy reach of analyst.

7.1.3 Laboratory Equipment and Instruments

The equipment in the laboratory must be adequate to permit proper analytical laboratory control of purification processes. Careful planning is necessary while equipping the laboratory to effect proper utilisation of the equipment. Proper maintenance of equipment and storage of chemicals must be in the hands of responsible analysts. A need-based planning to acquire consumable materials like glassware, chemicals and reagent is in general more important than procuring special equipment. Calibrated instruments should frequently be checked using standards. The instruments and equipment required for water quality assessment laboratories is given in the table below.

Table: Instruments and equipment for water quality assessment laboratory

S. No.	Items	Level of laboratory
Instruments		
1	Gas Chromatograph Mass Spectrometer (GCMS)	State
2	Atomic Absorption Spectrometer (AAS) with graphite furnace	State, Upgraded Division
3	Gas Liquid Chromatography (GLC)	State

S. No.	Items	Level of laboratory
4	High Performance Liquid Chromatography (HPLC)	State
5	Inductively Coupled Plasma Spectrometer (ICPS)	State
6	Scintillation counter	State
7	Mercury Analyser	State
8	Total Organic Carbon Analyser	State
9	Stereoscopic Microscope	State, Divisional
10	Flame Photometer	State, Divisional
11	Spectrophotometer (Visible and Ultraviolet)	State, Divisional
12	Nephlometer	State, Divisional, WTP
13	Monopan Digital Balance, Chemical	State, Divisional
14	Conductivity Meter	State, Divisional, WTP
15	pH Meter	State, Divisional
16	Jar Test Apparatus	State, Divisional, WTP
17	Specific Ion Meter	State,
18	Microscope	State,
19	PCR	State, Divisional
20	Laminar flow,	State, Divisional
21	Ultrapure water	State, Divisional
Equipment		
1	Microwave Oven	State,
2	Kjeldahl Nitrogen Analyser	State,
4	Arsine generator	State, Divisional
5	Muffle Furnace	State, Divisional
6	Magnetic Stirrer	State, Divisional
7	Oven	State, Divisional
8	Autoclave	State, Divisional
9	Membrane Filter Assembly	State, Divisional
10	Incubators 370°C and 440°C	State, Divisional
11	Centrifuge (adjustable rpm)	State, Divisional, WTP
12	Colour Comparator and comparator test set for residual Cl_2	State, Divisional, WTP
13	Colony Counter	State, Divisional, WTP
14	Vacuum Pump	State, Divisional, WTP
15	Heating Mantle and Hot Plates	State, Divisional, WTP
16	Specific Ion electrodes (F^-, Cyanide and others)	State,
17	Fume Cupboard	State, Divisional
18	Physical Balance	State, Divisional, WTP
19	Water Bath with 12 Concentric Holes and Discs	State, Divisional
20	Desiccators	State, Divisional, WTP

S. No.	Items	Level of laboratory
21	Soxhlet Extraction Unit	State, Divisional
22	BOD Incubator	State, Divisional
23	COD reactor	State, Divisional
24	Sieve Shaker with standard sieves	State, Divisional
25	Rotary Shaker	State, Divisional
26	Double distillation unit	State, Divisional, WTP
Miscellaneous		
1	Deep Freezer	State,
2	Refrigerator	State, Divisional
3	Fuel Gas cylinder or pipe gas supply	State, Divisional
4	Burners	State, Divisional, WTP
5	Fire Extinguisher	State, Divisional, WTP
6	First aid Kit	State, Divisional, WTP
7	Safety Equipment (Goggles, apron, gloves, gas mask)	State, Divisional, WTP
8	UPS /Inverter	State, Divisional
9	PC with printer	State, Divisional
10	Telephone	State, Divisional
11	Internet	State, Divisional
12	Motorcycles with sampling kits	Divisional
13	Air conditioner	State, Divisional
14	Ice Box	State, Divisional
15	Wash station	State, Divisional

7.1.4 Laboratory Furniture

The working benches should be of suitable height (0.75 to 1.0 metre) with acid resistant tops. Adequate gas, electric power and water points must be provided along the benches and services for gas, electricity and water can be fitted against the walls under the bench-work as much cupboard space as possible should be built-in, finishing flush to the bench-work, thus providing unobstructed floor space throughout.

Work tables and benches (Divisional Laboratory)

The work tables should be arranged along with walls. The wall side tables shall be generally 60 to 75 cms wide and centre tables shall be 140 cm wide to facilitate working space on both sides. The height of tables shall be around 90 cms for working in standing posture and 75 cms for working in sitting posture. Table tops shall be black acid resistant glossy sheets. Adequate number of cushioned working stools shall be provided. The list of furniture is given below:

S.No	Item	Quantity
1.	Laboratory table 1.5m x.75x1m (LxWxH)	6 Nos.
2.	Racks on lab table with two shelves 1.5m x 0.25 x 0.5m	6 Nos.

3.	Fume chamber with exhaust fan. Four legs of 1 mt. Height then glass cabinet of 2mt. H x 1ML x 0.5W	1 No.
4.	Wooden table with drawers 1.5 m x 0.75 m	6 Nos.
5.	Chairs	6 Nos.
6.	Stool	6 Nos.
7.	Bench-wooden	2 Nos.
8.	Steel cup board	6 Nos.
9.	Glass door cup board (for books+ chemicals storage)	6 Nos.

7.1.5 Reagents for physical and chemical analysis

Distilled water: Distilled or deionised (demineralised) water is used in the laboratory for dilution, preparation of reagent solutions, and final rinsing of glassware All the laboratories must have proper facility of distilled water depending on the nature of analysis undertaken, starting from double distilled to ultrapure. Ordinary distilled water is usually not pure. It may be contaminated by dissolved gases and by materials leached from the container in which it has been stored. Volatile organics distilled over from the feed water may be present, and non-volatile impurities may occasionally be carried over by the steam it is highly important that the still, storage tank, and any associated piping be carefully selected, installed, and maintained in such a way as to assure minimum contamination.

Water purity on the basis of dissolved salts. Degree of Purity	Maximum Conductivity (µS/cm)	Approximate Concentration of Dissolved Salts (mg/l)
Pure	10	2 to 5
Very Pure	1	0.2 to 0.5
Ultrapure	0.1	0.01 to 0.02

Reagent: Primary standards must be obtained from a reliable source, pre-treated, e.g., dried, under specified conditions, accurately prepared in calibrated volumetric glassware, and stored in containers that will not alter the reagent.

7.2 Laboratory Safety

While safety criteria are not an aspect of laboratory certification, laboratory personnel should apply general and customary safety practices as a part of good laboratory practices. Each laboratory is encouraged to have a safety plan as part of their standard operating procedure which includes personnel safety, training and protection. The Annexure-10 presents the standard operating procedures on practices that need to be followed to ensure laboratory safety.

7.3 Staffing requirements and functions

Staff requirements for water supply quality monitoring and surveillance vary widely according to the plant size, ecological and economic conditions. The envisaged functions of different laboratories within the proposed hierarchy and requisite staffing shall be as follows:

Laboratory	Envisaged Functions	Staffing
State Laboratory	It is envisaged to be a state of the art laboratory with NABL accreditation. It will • Analyse specific and new water/waste water issues • Undertake R&D activities as per benefit of the state. • It will select/establish a few baseline/reference stations in the state, based on hydro-geological characteristics and monitor the water quality using GIS	Chief Analyst-1 Senior Analysts - 3 (Chemist, Microbiologist, Sewage)

	• Impart in-house training to all laboratory personnel at regular intervals • Undertake analysis of all water quality parameters as per BIS/CPHEEO norms e.g.; heavy metals, toxic substances, pesticides, bacteriological, virological, biological & radiological analysis with sophisticated instruments • Ensure database management	Analysts – 4 (Chemist, Bacteriologist, Microbiologist, Sewage) Assistant Analysts – 3 (Chemist, Bacteriologist, Biologist) Laboratory Assistant – 6 Laboratory attendant-8 Computer Operator-2 Light Vehicle Driver-2 Clerk-1
Mobile Laboratory	It will be a self-sustaining laboratory equipped with instruments like AAS, GC etc. along with all routine laboratory equipment. It will • Move and operate in affected areas under calamities • Visit reference stations at regular intervals to perform at site analysis.	Senior Analyst-1 Laboratory Assistant-1 Jr. Laboratory Assistant -1 Laboratory attendant-1 Heavy Vehicle Driver-1
Upgraded Divisional Laboratory	It is envisaged to be a state of the art laboratory with NABL accreditation. It will • Undertake analysis of all routine water quality parameters, viz., heavy metals and bacteriological analysis with sophisticated instruments • Ensure that water supply from catchments to consumer can provide safe drinking water at the end point. • All works assigned to a typical divisional laboratory	Senior Analyst- 1 Analysts -2 (Chemist/Microbiologist/Sewage) Assistant Analysts -2 (Chemist/Bacteriologist) Laboratory Assistant-3 Laboratory attendant-4 Computer Operator-1 Light Vehicle Driver-1 Clerk-1
Divisional Laboratory	It will be a well-equipped laboratory capable of • Analysis of physicochemical & microbiological parameters of water & waste water • Supervise and guide all small laboratories in its jurisdiction on sampling, water quality analysis, data analysis, crosscheck of standard • Undertake routine monitoring & surveillance of distribution system and suggest corrective actions based on water quality analysis data • Routine Monitoring of identified control measures within water supply system • Identify contamination points within water supply systems, and control; • Validate & enter data in a standard database • Undertake analysis of all routine water quality parameters, viz., heavy metals, pesticides, bacteriological, and biological analysis with sophisticated instruments	Analysts -1 (Chemist/ Microbiologist) Assistant Analysts – 2 (Chemist/ Bacteriologist) Laboratory Assistant-1 Laboratory attendant-2 Computer Operator-1 Clerk-1

	• Establish area specific health-based targets for microbial and chemical quality of water • Take up independent public health surveillance for water safety.	
Basic Laboratory (WTP)	It will be a well-equipped laboratory capable of • Analysis of minimum required parameters as per SLB • Undertaking routine monitoring & surveillance of distribution system. • Routine monitoring of various stages of treatment plant • enter data in a standard database • For Smaller laboratories (<7.5 mld), one Junior Laboratory Assistant shall undertake the responsibility of Laboratory Assistant and Sample Collector	Analyst -1 (Larger WTPs) Laboratory Assistant-1 Laboratory attendant-2

ULB with piped water supply may be managed by a Junior Laboratory Assistant.

The table below presents the minimum staff requirement for water works laboratories (<200 mld capacity) as prescribed in CPHEEO manual (1999), mapped to the existing cadre structure in Odisha.

Suggested Staff*(CPHEEO manual, 1999, appendix 15.1)	WTP capacity > 7.5mld	WTP capacity up to 7.5 mld	Suggested Staff**(Modified as per existing cadre)
Water Analyst(Chemist)	1	-	Analyst Chemist
Water Analyst(Bacteriologist)	1	-	Analyst Microbiologist
Water Analyst	-	1	Assistant Analyst (Chemist)
Laboratory Technician	3	1	Laboratory Assistant
Typist cum Clerk	1	-	Typist cum Clerk
Sample Taker	3	1	Specimen Collector/ Lab. Att.
Laboratory Cleaner	3	2	Sweeper

Laboratories of large STP should be under the charge of a qualified and experienced analyst supported by junior technical staff having background in the field of chemistry, biology and bacteriology. The analyst should assimilate the details for functioning of the plants by experience and acquire the necessary preparedness for receiving further specialised training including performance interpretation and application of advanced techniques, which enable the analyst to participate in the efficient operation of the STP. The detailed computations of staff requirement for water testing laboratories in Odisha are presented in Annexure 16. The minimum educational qualifications required for the laboratory technical staff is given in Annexure 17.

Following is the staff requirement for water quality surveillance team:

Table: Suggested Water Quality Surveillance Team

S. No.	Level	Minimum Recommended Staff	Remarks
1	**Basic Laboratory**		
	a. Primary Health Center Level	1. Health/Sanitary Inspector 2. Laboratory Assistant/Technician 3. Lab. Attendant Laboratory	For periodical testing, samples shall be sent to District or State Health

	b. Municipal/District Level (Plant capacity >200 mld)	A – Class (5-10 lakhs or greater) 1. Senior Health Officer 2. Zonal Health Officer 3. Chief Health/Sanitary Inspector 4. Health/Sanitary Inspector 5. Chemist 6. Bacteriologist 7. Lab Assistant 8. Lab Attendant	
		B – Class (1-5 lakhs) 1. Health Officer 2. Health/Sanitary Inspector 3. Chemist 4. Lab. Assistant/technician 5. Lab. Attendant	
		C – Class (< 1 lakhs) 1. Chief Health/Sanitary Inspector 2. Health/Sanitary Inspector 3. Lab. Assistant/technician 4. Lab. Attendant	For periodical testing, samples shall be sent to District or State Health Laboratory
2	**State/Regional Level Laboratory**	Staff as per existing State Medical and Health Department norms	

Source: Annexure-9.4b of CPHEEO manual on operation & maintenance of water supply

7.4 Human resources development

7.4.1 Skill

The cost of data production in the analytical laboratory is based largely upon two factors- (a) the pay scale of the analyst and (b) the number of data units produced per unit of time. The analyst should be under some compulsion to produce a minimum number of tests per unit of time, but if the analyst is pushed to produce data at a rate beyond his capabilities, unreliable results may be produced. Further outsourced staffs, which do not have any accountability or are obligatory for the purpose, may produce erroneous data, which can lead to tragic situations. So, the officials in the quality control team need to be regular Government employees.

7.4.2 Training

The quality of the data produced by a water quality monitoring programme depends on the quality of the work done by field and laboratory staff. It is, therefore, important that staff is adequately trained for the work they are expected to do. As a result, monitoring agencies often develop training programmes that are specific to their needs. The content and extent of training programmes depend on the previous training and experience of staff, the range of activities involved in the monitoring programme and whether analytical work will be done at a central laboratory or regional laboratories, and the extent to which analyses will be performed in the field.

A comprehensive strategy for personnel development is advisable. This should include:

- Clear lines of responsibility and accountability,
- Job descriptions,
- Recruitment guidelines (qualifications, experience, skills requirements, etc.),
- Career structures,
- Mechanisms for enhancing the motivation of staff at all levels,
- Systems for staff appraisal and feedback, and often standardised training packages,
- Procedures, manuals and training manuals as appropriate to the work of laboratory

Training is not a once-only activity but should be a continuing process. Ideally, there should be a basic framework of courses for staff at all levels, followed by short courses, seminars and workshops. Supervision of work, in both the laboratory and the field, is essential and contributes to in-service training. It is particularly valuable in water quality monitoring programmes because it permits staff to gain “hands-on “experience, Laboratory staff, especially those in larger laboratories, need to be progressively trained and authorised to use certain items of equipment or undertake certain analyses, supplementing these with short courses, workshops and refresher training in specific topics.

Training should be flexible, responding to experience and feedback and taking account of the specific needs of individual staff members. In-house training can provide this flexibility and can be readily tailored to local requirements but it needs staff those are familiar with the necessary training techniques, usually senior laboratory and field staff

In its broadest sense, training should also be understood to include encouraging staff to join appropriate professional organisations, attend conferences and symposia, and communicate with peers in technical schools, colleges, universities and similar establishments.

7.4.3 Staff training records

All staff members are to have a training record, where levels of competency can be assigned by the Laboratory Manager. The competency level may be categorized as follows:

Level 1 – Staff member has been trained in the particular analytical procedure

Level 2 – Staff member has conducted the analysis under supervision

Level 3 - Staff member can conduct analysis unsupervised and has achieved Proficiency

7.5 Accreditation of Water Quality Testing Laboratories

Water Quality Testing Laboratories at all levels (i.e. state, divisional and WTP level) shall strive for accreditation in a phased manner. State level laboratories shall be given top priority for obtaining accreditation by NABL/ ISO-9001 at an early date. The laboratory, which intends to be accredited, shall have management requirements of ISO/IEC 17025:2005. They shall:

- have managerial and technical personnel with the authority and resources needed to carry out their duties and to initiate actions to prevent irregularities;
- have arrangements to ensure that its management and personnel are free from any undue internal and external commercial, financial and other pressures and influences that may adversely affect the quality of their work;
- have policies and procedures to ensure the protection of its confidential information and proprietary rights, including procedures for protecting the electronic storage and transmission of results;
- have policies and procedures to avoid involvement in any activities that would diminish confidence in its competence, impartiality, judgment or operational integrity;
- define the organization and management structure of the laboratory, its place in any parent organization, and the relationships between quality management, technical operations and support services;
- specify the responsibility, authority and interrelationships of all personnel who manage, perform or verify work affecting the quality of the tests and/or calibrations;
- provide adequate supervision of testing and calibration staff, including trainees, by persons familiar with methods and procedures, purpose of each test and/or calibration, and with the assessment of the test or calibration results;
- have technical management which has overall responsibility for the technical operations and the provision of the resources needed to ensure the required quality of laboratory operations;

- appoint a member of staff as quality manager who, irrespective of other duties and responsibilities, shall have defined responsibility and authority & he shall have direct access to the highest level of management at which decisions are made on laboratory policy or resources;

ANNEXURES

ANNEXURE 1: Contaminant Classes, their Availabilities, and Restrictions

Class	Examples (not exhaustive)	Sources	Access?
MICROBIOLOGICAL CONTAMINANTS			
Bacteria	*Bacillus anthracis, Brucella* spp., *Burkholderia* spp., *Campylobacter* spp., *Clostridium perfringens, E. coli* O157:H7, *Francisella tularensis, Salmonella typhi, Shigella* spp., *Vibrio cholerae, Yersinia pestis, Yersinia enterocolitica*	Naturally occurring,	Yes
Viruses	Caliciviruses, Enteroviruses, Hepatitis A/E, Variola, VEE virus	Naturally occurring,	Yes
Parasites	*Cryptosporidium parvum, Entamoeba histolytica, Toxoplasma gondii*	Naturally occurring,	No
CHEMICAL CONTAMINANTS – Inorganic			
Corrosives and caustics	Toilet bowl cleaners (hydrochloric acid), tree-root dissolver (sulfuric acid), drain cleaner (sodium hydroxide)	Retail, industry	No
Cyanide salts or cyanogenics	Sodium cyanide, potassium cyanide, amygdalin, cyanogen chloride, ferricyanide salts	Supplier, industry (esp. electroplating)	Yes
Metals	Mercury, lead, osmium, their salts, organic compounds, and complexes (even those of iron, cobalt, copper are toxic at high doses)	Industry, supplier, laboratory	Yes
Nonmetal oxyanions, organo-nonmetals	Arsenate, arsenite, selenite salts, organoarsenic, organoselenium compounds	Some retail, industry, supplier, laboratory	Yes
CHEMICAL CONTAMINANTS – Organic			
Fluorinated organics	Sodium trifluoroacetate (a rat poison), fluoroalcohols, fluorinated surfactants	Supplier, industry, laboratory	Yes
Hydrocarbons and their oxygenated and/or halogenated derivatives	Paint thinners, gasoline, kerosene, ketones (e.g., methyl isobutyl ketone), alcohols (e.g., methanol), ethers (e.g., methyl *tert*-butyl ether or MTBE), halo-hydrocarbons (e.g., dichloromethane, tetrachloroethene)	Retail, industry, laboratory, supplier	No
Insecticides	Organophosphates (e.g., Malathion), chlorinated organics (e.g., DDT), carbamates (e.g., Aldicarb) some alkaloids (e.g., nicotine)	Retail, industry,	Yes

Class	Examples (not exhaustive)	Sources	Access?
Malodorous, noxious, foul-tasting, and/or lachrymatory chemicals[4]	Thiols (e.g., mercaptoacetic acid, mercaptoethanol), amines (e.g., cadaverine, putrescine), inorganic esters (e.g., trimethylphosphite, dimethylsulfate, acrolein)	Laboratory, supplier, police supply, military depot	Yes
Organics, Water-miscible	Acetone, methanol, ethylene glycol (antifreeze), phenols, detergents	Retail, industry, supplier, laboratory	No
Pesticides other than insecticides	Herbicides (e.g., chlorophenoxy or atrazine derivatives), rodenticides (e.g., superwarfarins, zinc phosphide, α-naphthyl thiourea)	Retail, industry, agriculture,	Yes
Pharmaceuticals	cardiac glycosides, some alkaloids (e.g., vincristine), antineoplastic chemotherapies (e.g., aminopterin), anticoagulants (e.g., warfarin). Includes illicit drugs such as LSD, PCP, and heroin.	pharmacy, natural source	Yes
SCHEDULE 1 CHEMICAL WARFARE AGENTS			
Schedule 1 Chemical Weapons	organophosphate nerve agents (e.g., sarin, tabun, VX), vesicants, [nitrogen and sulfur mustards (chlorinated alkyl amines and thioethers, respectively)], Lewisite	Suppliers, military depots, some laboratories	Yes
BIOTOXINS			
Biologically produced toxins	Biotoxins from bacteria, plants, fungi, protists, defensive poisons in some marine or terrestrial animals. Examples include ricin, saxitoxin, botulinum toxins, T-2 mycotoxins, microcystins.	Laboratory, supplier, pharmacy, natural source	Yes
RADIOLOGICAL CONTAMINANTS			
Radionuclides	Does not refer to nuclear, thermonuclear, or neutron bombs. Radionuclides may be used in medical devices and industrial irradiators (Cesium-137 Iridium-192, Cobalt-60, Strontium-90).	Laboratory, state sources, waste facilities	Yes

1. The quantity of bacteria, viruses, or parasites needed for widespread contamination of a water system is not available in a typical clinical laboratory, although the seed cultures could be available. For viruses, vaccine production-grade volumes would be needed, requiring special equipment and facilities, perhaps with state-sponsorship.

2. Availability may be commercially limited for the more toxic metals, especially the heavy metals, which can be quite expensive. Iron and copper are readily available, but not usually in soluble (bio-available) forms.

3. Availability of arsenicals and selenium compounds in the retail sector has been reduced owing to environmental regulations, but such products can occasionally be found as part of older inventories of merchandise, especially in small-town hardware stores. Supplies of such materials may generally be too small to cause concern.

4. This grouping includes riot-control agents and other mucous membrane irritants.

5. The quantity available from laboratories, suppliers, and pharmacies needed for widespread contamination of a water system are typically not available from these sources. Many biotoxins that occur naturally would need to be purified or prepared to be of significant concern to water, which could make production beyond the capabilities of most terrorists.

ANNEXURE 2: Classification system for water-related diseases

Category	Example	Intervention
Water-borne	Diarrhoeal disease, cholera, dysentery, typhoid, infectious hepatitis	Improve drinking-water quality, prevent casual use of unprotected sources
Water-washed	Diarrhoeal disease, cholera, dysentery, trachoma, scabies, skin and eye infections, ARI (acute respiratory infections)	Increase water quantity used Improve hygiene
Water-based	Schistosomiasis, guinea worm	Reduce need for contact with contaminated water, reduce surface water contamination
Water-related (insect vector)	Malaria, onchocerciasis, dengue fever, Gambian sleeping sickness	Improve surface water management, destroy insect breeding sites, use mosquito netting

ANNEXURE 3: Sources and pathways for faecal contamination of Piped water systems

1) Groundwater source inadequately protected from contamination
2) Surface water intake inadequately protected from local sources of contamination (e.g., no fencing, broken fencing, poorly constructed or damaged intake structures, inadequate screening)
3) Treatment plant non-operational, operates intermittently (e.g., broken equipment, no treatment chemicals) or inadequately maintained and supervised (e.g., process control tests not carried out regularly, record keeping inadequate, poorly trained operators, incorrect storage of treatment chemicals)
4) Cracked storage tanks and reservoirs
5) Tank access covers or vents improperly sealed
6) Infrequent cleaning of storage tanks and reservoirs
7) Broken or leaking pipes, exposed pipes due to erosion or poor construction
8) Service interruptions causing pressure loss and thus potentially allowing the entry of contaminated surface and groundwater into system via pipes and fittings
9) Standing water around tap stands (standpipes) due to poor drainage
10) Open defecation near tap stands

ANNEXURE 4: Water Quality Standards (CPHEEO, BIS: 10500-2012)

S. No.	Characteristics	CPHEEO		BIS (IS:10500-2012)		Remarks
		*Acceptable	**Cause for rejection	Acceptable limit	Permissible limit in absence of alternate source	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Physical Parameters						
1.	Turbidity (NTU, Max)	1	10	1	5	
2.	Colour	5 (Units on platinum cobalt scale)	25	5 (Hazen Units, Max)	15	
3.	Taste and Odour	Unobjectionable	Unobjectionable	Agreeable	Agreeable	
4.	pH	7.0 to 8.5	< 6.5 to > 9.2	6.5 to 8.5	No relaxation	
5.	Total dissolved solids (mg/L)	500	2000	500	2000	
6.	Total hardness as $CaCO_3$ (mg/L)	200	600	200	600	
7.	Chlorides as Cl (mg/L)	200	1000	250	1000	
8.	Sulphates as SO_4 (mg/L)	200	400	200	400	Column (5): May be extended to 400 provided that Magnesium does not exceed 30
9.	Fluorides as F (mg/L)	1.0	1.5	1.0	1.5	
10.	Nitrates as NO_3 (mg/L)	45	45	45	No relaxation	
11.	Calcium as Ca (mg/L)	75	200	75	200	
12.	Magnesium as Mg (mg/L)	<30	150	30	100	Column (3): If there are 250 mg/L of sulphates, magnesium content can be increased to a maximum of 125 mg/L with the reduction of sulphates at the rate of 1 unit per every 2.5 units of sulphates
13.	Iron as Fe (mg/L)	0.1	1	0.3	No relaxation	Column (5): Total concentration of manganese (as Mn) and iron (as Fe) shall not exceed 0.3 mg/l
14.	Manganese as Mn (mg/L)	0.05	0.5	0.1	0.3	
15.	Copper as Cu (mg/L)	0.05	1.5	0.05	1.5	
16.	Aluminium as Al (mg/L)	0.03	0.2	0.03	0.2	
17.	Alkalinity (mg/L)	200	600	200 (as calcium carbonate)	600	
18.	Residual Chlorine (mg/L)	0.2	>1.0	0.2	1.0	Column (5): To be applicable only when water is chlorinated. Tested at consumer end. When protection against viral infection is required, it should be minimum 0.5 mg/l

S. No.	Characteristics	CPHEEO		BIS (IS:10500-2012)		Remarks
		*Acceptable	**Cause for rejection	Acceptable limit	Permissible limit in absence of alternate source	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
19.	Zinc as Zn (mg/L)	5	15	5	15	
20.	Phenolic compounds as Phenol (mg/L)	0.001	0.002	0.001	0.002	
21.	Anionic detergents as MBAS (mg/L)	0.2	1	0.2	1.0	
22.	Mineral Oil (mg/L)	0.01	0.03	0.5	No relaxation	
23.	Ammonia (mg/L)	-	-	0.5	No relaxation	
24.	Barium as Ba (mg/L)	-	-	0.7	No relaxation	
25.	Boron as B (mg/L)	-	-	0.5	1	
26.	Chloramines as Cl_2(mg/L)	-	-	4	No relaxation	
27.	Silver as Ag (mg/L)	-	-	0.1	No relaxation	
28.	Sulphide as SO_4	-	-	200	400	
Toxic Materials						
29.	Arsenic as As (mg/L)	0.01	0.05	0.01	0.05	
30.	Cadmium as Cd (mg/L)	0.01	0.01	0.003	No relaxation	
31.	Chromium as Hexavalent Cr (mg/L)	0.05	0.05	0.05	No relaxation	
32.	Cyanides as CN (mg/L)	0.05	0.05	0.05	No relaxation	
33.	Lead as Pb (mg/L)	0.05	0.05	0.01	No relaxation	
34.	Selenium as Se (mg/L)	0.01	0.01	0.01	No relaxation	
35.	Mercury as Hg (mg/L)	0.001	0.001	0.001	No relaxation	
36.	Polynuclear aromatic hydrocarbons (PAH) (µg/L)	0.2	0.2	0.0001	No relaxation	
37.	Pesticides (total, mg/L)	-	Given below			
38	Molybdenum as Mo (mg/L)	-	-	0.07	No relaxation	
39.	Nickel as Ni (mg/L)	-	-	0.02	No relaxation	
40.	Polychlorinated biphenyls (mg/L)	-	-	0.0005	No relaxation	
41.	Bromoform (mg/L)	-	-	0.1	No relaxation	
42.	Dibromochloromethane (mg/L)	-	-	0.1	No relaxation	

S. No.	Characteristics	CPHEEO		BIS (IS:10500-2012)		Remarks
		*Acceptable	**Cause for rejection	Acceptable limit	Permissible limit in absence of alternate source	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
43.	Bromodichloromethane (mg/L)	-	-	0.06	No relaxation	
44.	Chloroform (mg/L)	-	-	0.2	No relaxation	
Radioactivity[+]						
45.	Gross Alpha activity (Bq/L)	0.1	0.1	0.1	No relaxation	
46.	Gross Beta activity (Bq/L)	1.0	1.0	1.0	No relaxation	
Pesticide Residue Limits						
47.	Alachlor(µg/l)	-	-	20		Method of Test, Ref to USEPA 525.2, 507
48.	Atrazine(µg/l)	-	-	2		Method of Test, Ref to USEPA 525.2, 8141 A
49.	Aldrin/Dildrin(µg/l)	-	-	0.03		Method of Test, Ref to USEPA 508
50.	Alpha HCH(µg/l)	-	-	0.01		Method of Test, Ref to USEPA 508
51.	Beta HCH(µg/l)	-	-	0.04		Method of Test, Ref to USEPA 508
52.	Butachlor(µg/l)	-	-	125		Method of Test, Ref to USEPA 525.2, 8141 A
53.	Chlorpyriphos(µg/l)	-	-	30		Method of Test, Ref to USEPA 525.2, 8141 A
54.	Delta HCH(µg/l)	-	-	0.04		Method of Test, Ref to USEPA 508
55.	2,4 Dichlorophenoxyacetic acid(µg/l)	-	-	30		Method of Test, Ref to USEPA 515.1
56.	DDT (o, p and p, p – Isomers of DDT, DDE and DDD)(µg/l)	-	-	1		Method of Test, Ref to USEPA 508, AOAC 990.06
57.	Endosulfan (alpha, beta, and sulphate)	-	-	0.4		Method of Test, Ref to USEPA 508, AOAC 990.06
58.	Ethion(µg/l)	-	-	3		Method of Test, Ref to USEPA 1657 A
59.	Gamma — HCH (Lindane)(µg/l)	-	-	2		Method of Test, Ref to USEPA 508, AOAC 990.06
60.	Isoproturon(µg/l)	-	-	9		Method of Test, Ref to USEPA 532
61.	Malathion(µg/l)	-	-	190		Method of Test, Ref to USEPA 8141 A
62.	Methyl parathion(µg/l)	-	-	0.3		Method of Test, Ref to USEPA 8141 A, ISO 10695
63.	Monocrotophos(µg/l)	-	-	1		Method of Test, Ref to USEPA 8141 A
64.	Phorate(µg/l)	-	-	2		Method of Test, Ref to USEPA 8141 A
Micro-biological Quality						

S. No.	Characteristics	CPHEEO		BIS (IS:10500-2012)		Remarks
		*Acceptable	**Cause for rejection	Acceptable limit	Permissible limit in absence of alternate source	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
65.	E. coli or thermos-tolerant coliform bacteria			Shall not be detectable in any 100 ml sample		
66.	Total coliform bacteria					
Biological Quality						
67.	Bryozoal growths			Shall be absent		
68.	Animalcules			Shall be absent		
69.	Amoebic cysts			Shall be absent		
70.	Cercariae of schistosomiasis			Shall be absent		
71.	Cyclops vector of the embryos of Dracunculus medinensis			Shall be absent		
72.	Cryptosporidium			shall be absent in 10 litre of water		Method of Test, Ref to USEPA method 1622 or USEPA method 1623* or ISO 15553: 2006
73.	Giardia					Method of Test, Ref to USEPA method 1623* or ISO 15553: 2006.
74.	Algae			Shall be absent		
75.	Zooplanktons			Shall be absent		
76.	Flagellates			Shall be absent		

Notes:

1. *The figures indicated under the column (3)-Acceptable, are the limits up to which the water is generally acceptable to the consumers.
2. ** Figures in excess of those mentioned under ‘Acceptable’ render the water not acceptable, but still may be tolerated in the absence of alternative and better source but up to the limits indicated under column (4)-Cause for Rejection, above which the supply will have to be rejected.
3. + It is possible that some mine and spring waters may exceed these radioactivity limits and in such cases it is necessary to analyse the individual radionuclide in order to assess the acceptability or otherwise for public consumption.
4. In case of BIS standards, it is recommended that the acceptable limit as per column (5) is to be implemented. Values in excess of those mentioned under ‘acceptable’ render the water not suitable, but still may be tolerated in the absence of an alternative source but up to the limits indicated under ‘permissible limit in the absence of alternate source’ in column (6), above which the sources will have to be rejected.
5. In case of tests for Pesticides, the Test methods are for guidance and reference for testing laboratory. In case of two methods, USEPA method shall be the reference method.

ANNEXURE 5: List of parameters for Analysis

S.No.	Parameter		Category of Water Works Laboratories		
			I	II	III
1	Turbidity		*	*	*
2	Colour		*	*	*
3	Taste		*	*	*
4	Odour		*	*	*
5	pH		*	*	*
6	Conductivity		*	*	*
7	Chloride		*	*	*
8	Free & Saline Ammonia		*		
9	Albuminoidal Ammonia		*		
10	Alkalinity	Phenolphthalein	*	*	*
11		Total	*	*	*
12	Nitrite		*	*	*
13	Total Hardness		*	*	
14	Iron		*	*	*
15	Manganese				
16	Fluoride		*	*	*
17	Residual Chlorine		*	*	*
18	Total Solids		*		
19	Dissolved Solids		*		
20	Suspended Solids		*		
21	Chlorine in Bleaching Powder		*		
22	Jar Test		*	*	
23	Chlorine Demand		*	*	*
24	Arsenic		*		
25	Copper		*		
26	Cyanide		*		
27	Hexavalent Chromium		*		
28	Lead		*		
29	Selenium		*		
30	Zinc		*		
31	Mercury		*		
32	Coli form Presumptive		*	*	*
33	Coli form Confirmatory		*	*	*
34	E.Coli		*		
35	Faecal Coli		*		
36	Streptococci		*		

Source: CPHEEO Manual on Water Supply and Treatment, 1999

Categories of Water Works Laboratories:

Category-I: State Laboratory and Large Water Works with output greater than 7.5 MLD
Category-II: Water Works with output up to 7.5 MLD
Category-III: Other Water Works facility of treatment and storage followed by chlorination

ANNEXURE 6: Reporting Format

P.H.ENGINEERING LABORATORY ----------

Letter No._____/Dated_____

To,

The Assistant Engineer,

Time of Collection_____

Time of Testing_____

RAW WATER QUALITY

Color	Turbidity, NTU	pH	Chloride, mg/Litre	Alkalinity, mg/Litre	Remark

ANALYTICAL DATA OF ----------WATERSUPPLY ----------MGD PLANT

Source	Color	Turbidity, NTU	pH	Free Residual Chlorine, mg/Litre
Flocculated				
Clarified/Settled				
Filtered				
Sump				

ADVICE FOR ADDING DIFFERENT CHEMICALS

Dose of Chemicals	Ppm	Kg/Million Gallon	Remarks
Alum			
PAC			
Lime			

ANALYST

Memo No._____/Dated_____

Copy to Junior Engineer, PH Section, ---------- for information

ANALYST

ANNEXURE 7: Specimen form for water analysis report

Physical and Chemical Parameters

Name and address of the laboratory:
Laboratory reference No.:
Name, address and phone No. of sender:
Date of collection:
Sample source and location:
Date and time of receipt at laboratory:

Sl. No.	Parameters	Test method	Data	Standard value
1	Colour , Units of Pt-Co-scale			
2	Turbidity, NTU			
3	Alkalinity, $CaCO_3$, mg/L			
4	Hardness, $CaCO_3$, mg/L			
5	Conductivity, micromhos/cm			
6	Total solids, mg/L			
7	Anions by chromatography, g/L			
8	Cyanide, CN, mg/L			
9	Residual Chlorine, Cl, mg/L			
10	Chloride, Cl, mg/L			
11	Fluoride , F, mg/L			
12	Sulphate, SO_4, mg/L			
13	Nitrogen (Ammonia), N, mg/L			
14	Nitrogen (Nitrate), N, mg/L			
15	Nitrogen (Nitrite), N, mg/L			
16	Phosphate, PO_4, mg/L			
17	pH			
18	Dissolved Oxygen, , mg/L			
19	Aggregate organic parameters			
20	Phenol, µg/L			
21	Detergent—surfactants, mg/L			
22	Trihalomethane formation potential (TFP), µg/L			
23	Metals			
24	Aluminium, Al, mg/L			
25	Arsenic, As, mg/L			
26	Cadmium, Cd, mg/L			
27	Chromium, Cr, mg/L			
28	Copper, Cu, mg/L			
29	Iron, Fe, mg/L			
30	Lead, Pb, mg/L			
31	Manganese, Mn, mg/L			
32	Potassium, K , mg/L			
33	Sodium, Na , mg/L			
34	Selenium, Se, mg/L			
35	Zinc, Zn, mg/L			
36	Mercury, Hg, mg/L			
37	Trihalomethanes, µg/L			
38	Biochemical Oxygen Demand, , mg/L			
39	Chemical Oxygen Demand, , mg/L			
40	Total Organic Carbon, , mg/L			
41	Oil and Grease, mg/L			
42	Organochlorine Pesticides, µg/L			
43	Organ phosphorus Pesticides, µg/L			
44	Carbamate Pesticides, µg/L			

Date: Officer-in-charge

ANNEXURE 8: Specimen form for water analysis report-Bacteriological Parameters

Name and address of the laboratory:
Laboratory reference No.:
Name, address and phone No. of sender:
Date of collection:
Sample source and location:
Date and time of receipt at laboratory:

Date and time of completion of examination:

Sl. No.	Parameter	Remarks
1	Coli form bacteria	
2	Faecal coli form	
3	Faecal streptococci	
4	Clostridium perfringens	
5	Pseudomonas aeruginosa	
6	H_2S producing bacteria	
7	Coliphages and other bacteriopha ge	

Date: Officer-in-charge

ANNEXURE 9: Specimen form for water analysis report - Biological Parameter

Name and address of the laboratory:
Laboratory reference No.:
Name, address and phone No. of sender:
Date of collection:
Sample source and location:
Date and time of receipt at laboratory:

Date and time of completion of examination:

Sr. No.	**Parameters**	**Remarks**
1	Total count of phytoplankton, (organisms/mL):	
2	Total Count of zooplankton, (organisms/L):	

Date: Officer-in-charge

ANNEXURE 10: Standard Operating Procedure son Laboratory Practices

All the Standard Operating Procedures (SOP) shall be in an electronic format (MSWord or HTML) and made available to laboratory staff as “read-only” documents. SOPs (analytical and administrative) are revised when necessary, due to instrument/ technology changes, regulatory changes, etc. All changes would result in a new revision of SOP. Each new revision shall have a new revision number, an effective date, and shall list the SOP it is replacing.

SOP 01: Performance requirements for quality control

SOP 02: Sample Collection and Preservation-Chemical and Physical Quality

SOP 03: Sample Collection and Preservation-Microbiological Quality

SOP 04: Examples of Holding Times

SOP 05: Safety

SOP 06: Suggested preservative treatments and maximum permissible storage times

SOP 07: Recommended washing procedures for selected water quality variables

SOP 08: List of documents

SOP 09: Calibration records

SOP 10: Checklist for preparing for field work

SOP 11: Necessary checks to be carried out

Each laboratory should

1) Maintain SOPs that reflect all phases of current laboratory activities
2) Keep a list of SOPs
3) Ensure that current copies of SOPs are in the laboratory and in the QA Managers files;
4) Ensure that SOPs are reviewed annually and revised as changes are made;
5) Ensure that SOPs have signature pages and revisions dated.

SOP-01: Performance requirements for quality control

Item	Action Required	Frequency	Remarks
Autoclave	Check performance	Each use	--
Automatic Burettes, Dispensers and Pipettes	Accuracy of, and repeatability at volumes in use	Three months	
Balances	Zero check.	Each weighing	
Balances	Service and recalibrate	Annually	Annual servicing is recommended
Balances and Weights	Check accuracy	Monthly	Check balances and working weights against a set of reference weights
Bench Surface	Monitor for contamination	Weekly	Plate or swab method can be used to monitor bench surface contamination
Conductivity Meter	Checked using appropriate standards	Each use	
Glassware/Plastic ware	Inspect for cleanliness, etchings, chips/cracks, distortions (plastic)	Each use	--

pH meter	Calibrate using at least two appropriate standard buffers.	Daily or before use	Buffers need to be stored in appropriate containers and marked with an expiry date.
HACH DR series colorimeters		following repair or maintenance	Using supplied standards
Turbidity meters		Weekly	Using supplied standards
Hot-air oven	Check performance	Monthly	Commercially available Bacillus subtilis spore strips or spore suspension can be used
Incubator	Check temperature	Twice daily	--
Media	Check pH and appearance	Each use	--
Membrane filtration equipment	Check for leaks and surface scratches	Each use	--
Refrigerator	Check temperature	Daily	--
Thermometers	Check accuracy	Annually	Use thermometers graduated in increments of 0.5°C; If possible, use a submersible thermometer for 44.5°C water bath, graduated to 0.2°C.

SOP-02: Sample Collection and Preservation - Chemical and Physical Quality

Sampling points should: be	• Preferably in buildings in with consistent water use. • Be accessible during the time you normally collect samples, • The sampling sites should be permanent
Do not obtain the water sample from faucets	• are seldom used; • drip or leak (e.g., leak around stem); • are dusty, dirty or corroded; • are pointed upwards • cannot deliver a smooth stream of water; • contain an aerator or screen (remove screen or aerator if this type of • faucet is chosen); • are connected to home drinking water treatment units, including water softeners • are outdoors
Container	• For most basic parameters, use a clean polyethylene bottle available from water quality laboratories • For additional or specialized parameters, discuss the requirements with the laboratory or a trained professional before sampling. • Label the bottle with location of the water source and/or sampling location, date, and time. • Make sure all information on the requisition is filled out completely.
Flush the System	• If the sample is to be taken from a tap or pump, allow the water to run for 10minutes if possible before collection. This will help to remove stagnant water that may have artificially elevated metal concentrations from the system.
Collect the Sample	• Rinse the bottle and cap 2 to 3 times unless specialized sampling requires non-rinse procedures. • Turn flow volume down so that water runs gently.

	• Sample for sensitive parameters (organics, metals) first. Filtration and preservation may be necessary for metals, depending on the purpose of sampling. • Fill bottle to top (overflow) and cap tightly with no air gap. • If a treatment device is in place to remove any chemical or physical substances, two samples shall be collected, one sample from the raw water source and one sample from a point after treatment.
Storage and Transport	• Samples shall be kept in a refrigerator or cooler with ice packs to maintain a temperature of 4OC until delivered to the lab. Samples should not be frozen. • Samples should be kept in the dark. • Transport the sample to the laboratory as soon as possible, preferably within 24 hours.

SOP- 03: Sample Collection and Preservation - Microbiological Quality

Container	• Use a sterilized sample bottle containing sodium thiosulfate preservative (a chlorine neutralizer). , from water quality laboratories, or from hospitals. • Keep sample containers clean and free from contamination before and after collecting the sample. Do NOT open them prior to collecting the sample. • Examine the sample bottle for cracks, a missing seal, or other signs that its sterility may be compromised. If any of these indications are found, discard the bottle and use a suitable one. • Label the bottle with the water supply owner's name, location of the water source and/or sampling location, date, and time.
Flush the System	• For locations at which the sample must be collected from a tap, inspect the outside of the faucet. If water leaks around the outside of the faucet, select a different sampling site. • Remove any aerators, strainers, attachments, or purification devices from the tap. If necessary, remove debris and sterilize the faucet outlet, for example by swabbing with a disinfecting wipe. • DO NOT take samples from a flexible hose or garden hose or outside hose bib. • Sample from the cold water faucets only. • If the sample is to be taken from a tap or a pump, allow the water to run for at least 5 minutes before collection. This will help to remove stagnant water from the system.
Collect the Sample	• If there is a chlorine disinfection treatment unit, measure and record chlorine residual. Normally free chlorine residual is measured; however, total chlorine residuals may be required on occasion. In either case, the chlorine residual should be recorded on the lab requisition form and be marked "F" or "T" to indicate free or total chlorine residual, respectively. • Before taking the sample, reduce the tap flow rate to approximately the width of a pencil before taking the sample. The flow rate should be low enough to ensure that no splashing occurs as the container is filled. • Do not adjust the flow rate while taking the sample. At sampling points where water runs continuously, do not adjust flow rate. • While holding the sample container at the base, remove the seal around the cap before attempting to open the bottle. • Remove the cap with the free hand. Be careful NOT TO TOUCH the inside of the bottle cap or bottle lip. Continue to hold the cap in one hand with the inside facing down while the bottle is being filled. Do NOT touch the interior of the cap or lay it down. • Do NOT breathe on the bottle or cap. • Do NOT rinse the bottle.

	• Fill the bottle to the fill line. Do NOT allow the bottle to overflow. Carefully replace the cap. • Complete the laboratory requisition form. Include all required information including sampling location, date, time, etc. and who took the sample. • All water samples are to be analysed for total coliform and *E. coli*.
Storage and Transport	• Samples shall be kept in a refrigerator or cooler with ice packs to maintain a temperature of 4OC until delivered to the lab. Samples should not be frozen. • Transport the sample to the laboratory as soon as possible and definitely within 24 hours of collection. • Check ahead with the lab about day and/or time deadlines for sample acceptance to ensure meeting the 24-hour criterion.

SOP- 04: Examples of Holding Times

Analyte	Laboratory Holding Time*
pH, Dissolved Inorganic Carbon (DIC)	72 hours
Specific Conductance ,Acid Neutralizing Capacity (ANC)	7 days
Turbidity	3 days
Dissolved Organic Carbon (DOC), preserved with H2SO4	14 days
Ammonia nitrogen	48 hours
Nitrate/nitrite nitrogen, Silica, Anions	7 days
Total Nitrogen & Total Phosphorus, until digestion	28 days
Anions (chloride and sulphate only)	28 days
Cations (Ca, Mg, Na, K, Fe)	6 months

SOP-05: Safety

Precautions with Hazardous Chemicals	• All containers must be clearly labelled and read before opening. • Minimal stock of corrosive or flammable solvents only may be kept in work room. • Low boiling point liquids must be kept in fridge. • Never carry bottles by neck alone. Open bottles with care.
Spillage of Hazardous Chemicals	• If amount is small, dilute with water or detergent. It amount is large protective apron, rubber gloves and boots are worn and treatment carried out according to wall chart showing how to manage chemical spillage. • Hydrochloric acid and sulphuric acid can be neutralized with anhydrous sodium carbonate then shovelled into a plastic bucket which is subsequently diluted by water and run to waste. Ammonia solution, ethanol, methanol and formalin are best treated by diluting with water, collection and running to waste. Windows must be opened.
First Aid	• The First Chart should be mounted on a nearby wall. The first aid box must be accessible with Laboratory Staff. An emergency eye wash bottle with a bottle of sterilised water should be readily available. A Universal poison antidote is useful.
Avoidance of Hazards of Equipment	• Trained staff should operate the equipment. • Operating instructions should be followed. • Check the autoclave filled with water to correct level before loading.

	• Water or moisture on electrical fittings is dangerous. • If fire breaks out, electrical equipment should immediately be switched off • When not in use switch off and withdraw plug from socket. • Avoid use of multi-adaptors, if have to use it, must be fitted with fuses.
Fire extinguishers	• Dry powder extinguishers or sand are suitable for liquids on fire • CO2 extinguishers suitable for all types of fire
Do's and don'ts in laboratory	• Never eat, smoke or drink in laboratory • Never mouth pipette • Wash hands before starting work, • Preferably wear a clean laboratory coat. • Regularly clean working area with disinfectant. • Use only media and equipment known to be sterile. • Open tubes or petri dishes for minimum time. • All cultures tubes, petri dishes should be autoclaved before disposal • All used pipettes must be discarded by immersing in disinfectant • Avoid splashing infectious material creating aerosols

SOP-06: Suggested preservative treatments and maximum permissible storage times

Variable	Recommended container[1]	Preservative	Max. permissible storage time
Alkalinity	Polyethylene	Cool 4 °C	24 h
Aluminium	Polyethylene	2 ml Conc. HNO2 per litre of sample	6 months
Ammonia,	Polyethylene	Cool 4 °C2 ml 40% H2SO4 I-1	24 h
Arsenic	Polyethylene	Cool 4 °C	6 months
BOD	Polyethylene	Cool 4 °C	4h
Boron	Polyethylene	Cool 4 °C	6 months
Cadmium	Polyethylene	2 ml Conc. HNO3per litre of sample	6 months
Calcium	Polyethylene	Cool 4 °C	7 days
Carbonate pesticides	Glass	H2SO4 to pH < 4, 10g Na2SO4 I^{-1}	Extract immediately
Chloride	Polyethylene	Cool 4 °C	7 days
Chlorinated hydrocarbon	Glass	Cool 4 °C	Extract immediately
Chlorophyll	Plastic Petri dish	Filter on GF/C filter; freeze -20 °C	7 days
Chromium	Polyethylene	2 ml Conc. HNO2 per litre of sample	6 months
COD	Polyethylene	Cool 4 °C	24 h
Copper	Polyethylene	2 ml Conc. HNO2 I^{-1} sample	6 months
Dissolved oxygen	Glass	Fix on site	6h

(Winkler)			
Electrical conductivity	Polyethylene	Cool, 4 °C	24 h
Fluoride	Polyethylene	Cool 4 °C	7 days
Iron	Polyethylene	2 ml Conc. HNO2 per litre of sample	6 months
Kjeldahl	Polyethylene	Cool 4 °C	24 h
Lead	Polyethylene	2 ml Conc. HNO2 per litre of sample	6 months
Magnesium	Polyethylene	Cool 4 °C	7 days
Manganese	Polyethylene	2 ml Conc. HNO3per litre of sample	6 months
Mercury	Glass or teflon	1 ml Conc. H2SO4 + 1 ml 5% 2Cr2O7	1 month
Nickel	Polyethylene	2 ml Conc. HNO2 per litre of sample	6 months
Nitrate + Nitrite	Polyethylene	Cool 4 °C	24 h
Organic nitrogen	Polyethylene	Cool 4 °C	24 h
Organic particulates	Plastic Petri dish	Filter using GF/C filter, Cool 4 °C	6 months
Organophosphorus Pesticides	Glass	Cool, 4 °C, 10% HCl to pH 4.4	No holding, extraction on site
Pentachlorophenol	Glass	H2SO4 to pH < 4, 0.5g CuSO4 F1 sample; Cool 4 °C	24 h
pH	Polyethylene	None	6h
Phenolics	Glass	H3PO4 to pH < 4, 1.0g CuSO4 r1 sample; Cool 4 °C	24 h
Phenoxy acid herbicides	Glass	Cool 4 °C	Extract immediately
Phosphorus Dissolved	Glass	Filter on site using 0.45 µm filter	24 h
Potassium	Polyethylene	Cool, 4 °C	7 days
Residue	Polyethylene	Cool, 4 °C	7 days
Selenium	Polyethylene	1.5 ml Conc. HNO3I-1sample	6 months
Silica	Polyethylene	Cool, 4 °C	7 days
Sodium	Polyethylene	Cool, 4 °C	7 days
Sulphate	Polyethylene	Cool, 4 °C	7 days
Zinc	Polyethylene	2 ml Conc. HNO3per litre of sample	6 months

SOP-07: Recommended washing procedures for selected water quality variables

Variable(s) to be analysed	Recommended container[1]	Washing procedure
Organochlorinated pesticides and PCBs Organophosphorus	1,000 ml glass (amber) with teflon-linedcap	Rinse three times with tap water, once with chromic acid[2], three times with organic-free water, twice with washing acetone, once with special grade[3] acetone, twice with pesticide grade hexane and dry (uncapped) in a hot air oven at 360 °C
Pentachlorophenol Phenolics Phenoxy acid herbicides	1,000 ml glass (amber) with teflon-linedcap	Rinse three times with tap water, once with chromic acid[2], three times with organic-free water, twice with washing acetone, once with special grade[3] acetone, twice with pesticide grade hexane and dry (uncapped) in a hot air oven at 360 °C for at least 1 h
Aluminium, Antimony, Barium, Beryllium, Cadmium,Chromium[4], Cobalt, Copper, Iron, Lead, Lithium, Manganese, Molybdenum, Nickel, Selenium, Strontium, Vanadium, Zinc	500-1,000 ml polyethylene (depending upon number of metals to be determined)	Rinse three times with tap water, once with chromic acid[2], three times with tap water, once with 1:1 nitric acid and then three times with ultrapure distilled water[5] in that order
Mercury	100 ml glass	Rinse three times with tap water, once with chromic acid[2], three times with tap water, once with 1:1 nitric acid and then three times with ultrapure distilled water[5] in that order
Acidity, Alkalinity, Arsenic, Calcium, Chloride, Colour, Fluoride, Hardness, Magnesium, Non- filterable residue, pH, Potassium, Sodium, Specific conductance, Sulphate, Turbidity	1,000 ml polyethylene	Rinse three times with tap water, once with chromic acid[2], three times with tap water, once with 1:1 nitric acid and then three times with distilled water in that order
Carbon, total organic Nitrogen: ammonia Nitrogen: nitrate, nitrite Nitrogen: total	250 ml polyethylene	Rinse three times with tap water, once with chromic acid[2], three times with tap water, and three times with distilled water, in that order
Phosphorus, total	50 ml glass	Rinse three times with tap water, once with chromic acid[2], three times with tap water, and three times with distilled water, in that order

1 Teflon containers can also be used to replace either the recommended polyethylene or glass containers

2 Chromic acid - 35 ml saturated Na2Cr2O7 per litre reagent grade conc. H_2SO_4

3 Special grade acetone - pesticide grade when GC analysis to be performed, UV grade for LC analysis

4 Chromic acid should not be used when the sample will be analysed for chromium

5 Ultrapure distilled water is obtained by passing distilled water through a Corning model AG-11 all-glass distillation unit and then through a Millipore Super Q Ultrapure Water System containing a prefilter cartridge, an activated carbon cartridge and a mixed bed deionisation cartridge

SOP-08: List of documents

The following documents are to be maintained in each laboratory:

a) Report on collection and codification of samples
b) Proforma for test report
c) Report on number of samples tested
d) Statement of recurring expenditure for operation of laboratory
e) Stock register of consumables
f) Stock register of equipment/furniture
g) Attendance registers of the staff

SOP-09: Calibration Records

Records for all equipment calibrations, including external and internal certificates are to be kept in the Equipment Calibration Data folder in the Laboratory Manager's office. For each meter or instrument a Calibration Record Form must record the following information:

a) Laboratory Equipment Number
b) Description.
c) Manufacturer's name.
d) Equipment serial number.
e) Model number.
f) Location or section where used.
g) Calibration frequency.
h) Date calibration is performed.
i) Name of person performing the calibration.
j) Results of calibration.

SOP-10: Checklist for preparing for field work

Paperwork	√ Inventory details of sampling stations; maps √ List of samples required at each sampling station √ List of stations where water level readings are to be recorded
Co-ordination	√ Local co-ordination, for example, to ensure access to sites on restricted/ private land √ Institutional co-ordination, for example, for travel arrangements or sample transport √ Notify laboratories of expected date and time of sample arrival √ sources of information on local weather conditions and feasibility of travel
For sampling	√ Sample bottles, preservatives, labels and marker pens √ Sample storage/transit containers and ice packs √ Filtering apparatus (if required) √ Samplers/sampling equipment √ Standard operating procedures for sampling √ Spares of all above items if possible and when appropriate
For documentation	√ Pens/wax crayons √ Sample labels √ Field notebook √ Report forms
For on-site testing	√ List of analyses to be performed on site √ Check stocks of consumables (including distilled water, pH buffers, standards and blanks); replenish and refresh as appropriate √ Check and calibrate meters (pH, conductivity, dissolved oxygen, turbidity, thermometers) √ Standard operating procedures and equipment manuals √ Spares (e.g. batteries)

Safety	√ First-aid kit √ Fire extinguisher (if appropriate)
Transport	√ Does assigned vehicle have sufficient capacity for personnel, supplies and equipment? √ Is vehicle road-worthy? Check battery, lubrication, coolant, windshield washer √ Is there sufficient fuel for the trip, either in the tank, in fuel cans, or available en-route? √ Is the spare tyre inflated; is there a jack, wheel wrench and tool kit?
Double-check	√ When was equipment last calibrated? √ Itinerary against travel details on inventory √ Accessories for equipment and meters (including cables, chargers and spare batteries) and consumables

SOP11: Necessary checks to be carried out when a problem is detected with an analytical method

Item	Checks
Calculations and records	Check calculations for a transposition of digits or arithmetic errors. Confirm that results have been recorded in the proper units and that any transfer of data from one record to another has been made correctly.
Standard solutions	Check the standard solutions that are used for calibrating equipment. Old solutions may have deteriorated and errors may have occurred in the preparation of new ones. Check on storage conditions, the age of solutions and their expected shelf-life.
Reagents	Check whether old reagents have deteriorated. Check fresh reagents to ensure that they have been properly prepared. Check the storage conditions of reagents, especially those that must be stored away from the light or at a controlled temperature. Check the shelf-life of reagents, discarding any that are outdated or have been improperly stored.
Equipment	Check calibration records and maintenance records for all reagent dispensers and measuring equipment used for the analysis of the variable where the method is out of control. Items such as automatic pipettes, balances and spectrophotometers should be checked and recalibrated if appropriate. Ascertain that equipment is being properly used.
Quality control materials	Check on the storage conditions of quality control materials, ensuring that bottles are tightly sealed and that they are not being subjected to extremes of temperature. Run analyses on several aliquots to determine whether the concentration of the variable remains within two standard deviations of the target value and close to the mean of the last 20 determinations.

ANNEXURE 11: Sanitary Inspection Form for Water-Treatment Plant

I. General information Water Treatment Plant	
1. Date of survey	Date / Month / Year
2. Survey of	Source…… Intake…… Treatment plant…… Distribution……
3. Carried out by	Name of person…… Agency……
4. Name of supply	State…… District…… Treatment plant……
5. Address	
6. Person in charge	
7. Year started operation	
8. Area served	…… Population served……
9. Treatment-plant capacity	Designed…… Actual ……
10. Security of plant Fence (Y/N)	…… Security Guard (Y/N) ……
II. Source	
1. Type of water source	Reservoir…… Stream…… River…… Well…… Others……
III. Intake	
1. Is the intake adequate with respect to:	Location? Y/N …… Structure? Y/N…… Maintenance? Y/N…… Pollution sources in the vicinity? Y/N……
IV. Treatment processes employed	
1. Fine screen	
2. Grit chamber	
3. Oil and grease trap	
4. Pre-sedimentation	
5. Pre-disinfection/oxidation	Chlorine gas Bleaching powder Other
6. Activated carbon treatment	
7. Aeration	
8. Coagulation and flocculation	Lime Alum

	Others	
9. Sedimentation		
10. Filtration		
11. Disinfection		
12. Other processes (specify):		
V. Sedimentation		
1. No. of sedimentation tank		
2. Frequency of desludging		
3. Type of desludging facility		
4. Method of sludge disposal		
5. General appearance of clarified water		
6. Turbidity (NTU) at……	(inlet) at ……(outlet)	
VI. Filtration		
1. No. of filters		
2. Filtration rate		
3. Filter run		
4. Depth of gravel		
5. Depth of sand		
VII. Backwashing		
1. Criteria used for initiating backwashing:	Air scour:	……..Rate ……..Duration
	Water scour:	……..Rate ……..Duration
2. Distribution of air and water supply in the sand bed:	Even Uneven	
3. Capacity of clean water for backwash		
4. Any mud balls or cracks in the filter bed?	Before backwash..... After backwash.....	
5. Where does the wash water go?		
VIII. Chlorination		
1. Any interruption in chlorination?		
2. Frequency of interruption:		
3. Cause of interruption:		
4. Type of chemical used:		
5. Dosage of chemical		
6. Safety equipment and measures		
7. Reserve stock of disinfectant……	Quantity:	
8. Storage conditions		
IX. Clear-water tank(s)		

1. No. of tanks	
2. Capacity of each tank	
3. Concentration of free residual chlorine	
4. pH:	
5. Chemical used for pH adjustment and its dosage	
6. Any leak in the tank?	
7. Is the tank properly covered and locked?	
8. Any scum or foreign substances in the tank?	
9. Are air vents and overflow pipes protected by screens?	
X. Process control	
1. Jar test	Yes/ No/ Frequently
2. Ph	Yes/ No/ Frequently
3. Concentration of free residual chlorine	Yes/ No/ Frequently
4. Free residual chlorine	Yes/ No/ Frequently
5. Colour	Yes/ No/ Frequently
6. Turbidity	Yes/ No/ Frequently
7. E.coli/thermos-tolerant coli	
8. Fluoride	
9. Others	
XI. Record keeping	
1. Chemical consumption	
2. Process-control tests	
3. Bacteriological examination	
4. Residual chlorine	
5. Others	
XII. Maintenance	
1. Screen	Cleaning…… Calibrating/oiling/greasing……..
2. Pumping facility	
3. Chlorine-dosing facility	
4. Alum-dosing facility	
5. Fluoride-dosing facility	
6. Instrument (gauge, recording devices, etc.):	
7. General housekeeping	
8. Storage of chemicals	Adequate…….. Inadequate……
XIII. Personnel	

1. No. of present staff	Permanent…….. Casual……
2. Academic level of the plant superintendent or the most senior operator of the treatment plant	
3. Length of service in present water-treatment plant	
4. Total experience in water treatment	
XIV. Complaints received	
1. From operators:	….
2. From management:	….

XV. Problems (if any) with:		
1. Fine screen:	(Y/N)	Description of Problems (if any)
2. Grit chamber	(Y/N)	
3. Oil and grease trap:	(Y/N)	
4. Pre-sedimentation:	(Y/N)	
5. Activated carbon	(Y/N)	
6. Aeration:	(Y/N)	
7. Coagulation and flocculation:	(Y/N)	
8. Sedimentation:	(Y/N)	
9. Filtration:	(Y/N)	
10. Fluoridation:	(Y/N)	
11. Disinfection:	(Y/N)	
12. Other process:	(Y/N)	
13. Process control:	(Y/N)	
14. Record keeping:	(Y/N)	
15. Maintenance:	(Y/N)	

XVI. Flow diagram of water works (insert diagram)

XVII. Remedial measures recommended	
1. Measures to be taken immediately	…. ….
2. Measures to be taken later on	…. ….
3. Have problems identified in the previous sanitary survey been corrected? …. ….	
Signature of Inspector……..	

ANNEXURE 12: Sanitary Inspection Form for Piped Water Distribution

I. Type of facility PIPED DISTRIBUTION	
1. General information:	Name of the ULB.....
2. Code no. …… Address.....	
3. Water authority/community representative signature.....	
4. Date of visit.....	
5. Water sample taken?.....	Sample no.....
	Thermotolerant coliform grade.....

II.	Specific diagnostic information for assessment	Risk
1.	Is there any point of leakage between source and reservoir?	(Y/N)
2.	If there are any pressure break boxes, are their covers unsanitary?	(Y/N)
3.	If there is a reservoir:	(Y/N)
4.	Is the inspection cover unsanitary?	(Y/N)
5.	Are any air vents unsanitary?	(Y/N)
6.	Is the reservoir cracked or leaking?	(Y/N)
7.	Are there any leaks in the distribution system?	(Y/N)
8.	Is the area around the tap stand unfenced (dry stone wall and/or fencing incomplete)?	(Y/N)
9.	Does water accumulate near the tap stand (requires improved drainage canal)?	(Y/N)
10.	Are there human excreta within 10m of the tap stand?	(Y/N)
11.	Is the plinth cracked or eroded?	(Y/N)
12.	Does the tap leak?	(Y/N)
Total risk score		
Contamination risk score: 10–11 5 very high; 6–9 5 high; 3–5 5 intermediate; 0–2 5 low		
Results and recommendations		
The following important points of risk were noted: ..... (List nos. 1–11) and the authority advised on remedial action.		
Signature of Sanitary Inspector.....		

ANNEXURE 13: Sanitary Inspection Form for Filling Stations, tanker trucks, & household tanks

I. Type of facility: FILLING STATIONS, TANKER TRUCKS, AND HOUSEHOLD TANKS			
1. General information:	Name of the ULB.....		
2. Code no. ……..	Address.....		
3. Water authority/community representative signature.....			
4. Date of visit.....			
5. Water sample taken.....	Sample no.....	Thermotolerant coliform grade……	
Specific diagnostic information for assessment Risk			**Risk**
II. Tanker filling stations			
Is the chlorine level at the filling station less than 0.5mg/litre?			(Y/N)
Is the filling station excluded from the routine quality-control programme of the water authority?			(Y/N)
Is the discharge pipe unsanitary?			(Y/N)
i. Tanker trucks			
Is the tanker ever used for transporting other liquids besides drinking-water?			(Y/N)
Is the filler hole unsanitary, or is the lid missing?			(Y/N)
Is the delivery hose nozzle dirty or stored unsafely?			(Y/N)
ii. Domestic storage tanks			
Can contaminants (e.g. soil on the inside of lid) enter the tank during filling?			(Y/N)
Does the tank lack a cover?			(Y/N)
Does the tank need a tap for withdrawal of water?			(Y/N)
Is there stagnant water around the storage tank?			(Y/N)
Total score of risks..... /10			
Contamination risk score: 9–10 5 very high; 6–8 5 high; 3–5 5 intermediate;0–2 5 low			
II. Results and recommendations			
The following important points of risk were noted: ..... (List nos. 1–10) and the authority advised on remedial action.			
Signature of Sanitary Inspector.....			

ANNEXURE 14: Sanitary Inspection Form for Deep Borehole with mechanical pump

I. Type of facility DEEP BOREHOLE WITH MECHANICAL PUMP		
1. General information:	Name of the ULB.....	
2. Code no. ……..	Address..... .	
3. Water authority/community representative signature.....		
4. Date of visit.....		
5. Water sample taken.....	Sample no.....	Thermotolerant coliform grade……

II. Specific diagnostic information for assessment	Risk
1. Is there a latrine or sewer within 15–20m of the pump house?	(Y/N)
2. Is the nearest latrine a pit latrine that percolates to soil, i.e. un-sewered?	(Y/N)
3. Is there any other source of pollution (e.g. animal excreta, rubbish, and surface water) within 10m of the borehole?	(Y/N)
4. Is there an uncapped well within 15–20m of the borehole?	(Y/N)
5. Is the drainage area around the pump house faulty? Is it broken, permitting ponding and/or leakage to ground?	(Y/N)
6. Is the fencing around the installation damaged in any way which would permit any unauthorized entry or allow animals access?	(Y/N)
7. Is the floor of the pump house permeable to water?	(Y/N)
8. Is the well seal unsanitary?	(Y/N)
9. Is the chlorination functioning properly?	(Y/N)
10. Is chlorine present at the sampling tap?	(Y/N)
Total score of risks	..... /10
(Contamination risk score:9–10 5 very high; 6–8 5 high; 3–5 5 intermediate;0–2 5 low)	

III. Results and recommendations
The following important points of risk were noted: ..... (List nos. 1–10) and the authority advised on remedial action.
Signature of Sanitary Inspector.....

ANNEXURE 15: Quality Testing at Waste Water treatment facility

1. General Standards of Discharge of Environmental Pollutants, Part A: Effluents as per Schedule VI of the Environmental (Protection) Rules 1986 and National River Conservation

Sl. No.	Characteristics	Standards			
		Inland Surface Water	Public Sewers	Land for Irrigation	Marine Coastal Areas
1	Colour and odour	(B)	(A)	(B)	(B)
2	SS	100	600	200	(C), (D)
3	Particle size of SS	(E)	-	-	(F), (G)
4	pH value	5.5 to 9.0			
5	Temperature	(H)	-	-	(H)
6	Oil and Grease	10	20	10	10
7	Total and Residual chlorine	1.0	-	-	1.0
8	Ammoniacal Nitrogen (as N)	50	50	-	50
9	Total Kjeldahl Nitrogen, (TKN) (As N)	100	-	-	50
10	Free ammonia (as NH_3)	5.0	-	-	5.0
11	Biochemical Oxygen Demand	30	350	100	100
12	Chemical Oxygen Demand	250	-	-	250
13	Arsenic (as As)	0.2			
14	Mercury (as Hg)	0.01	0.01	-	0.01
15	Lead (as Pb)	0.1	1.0	-	2.0
16	Cadmium (as Cd)	2.0	1.0	-	2.0
17	Hexavalent Chromium (as Cr 6+)	0.1	2.0	-	1.0
18	Total Chromium (as Cr)	2.0	2.0	-	2.0
19	Copper (as Cu)	3.0	3.0	-	3.0
20	Zinc (as Zn)	5.0	15.0	-	15.0
21	Selenium (as Se)	0.05	0.05	-	0.05
22	Nickel (as Se)	3.0	3.0	-	5.0
23	Cyanide (as CN)	0.2	2.0	0.2	0.2
24	Fluoride (as F)	2.0	15.0	-	15.0
25	Dissolved phosphates (as P)	5.0	-	-	-
26	Sulphide (as S)	2.0	-	-	5.0
27	Phenolic compounds (as C_6H_5OH)	1.0	5.0	-	5.0
28	Radioactive materials				
	Alpha emitters, micro curie/L	10^{-7}	10^{-7}	10^{-8}	10^{-7}
	Beta emitters, micro curie/L	10^{-6}	10^{-6}	10^{-7}	10^{-6}
29	Bio-assay test	(I)			
30	Manganese (as Mn),	2.0	2.0	-	2.0
31	Iron (as Fe),	3.0	3.0	-	3.0
32	Vanadium (as V),	0.2	0.2	-	0.2
33	Nitrate Nitrogen (as N)	10.0	-	-	20.0
34	Faecal Coliform, MPN/ 100 ml of discharge	onto land		onto water	
		(J)	(K)	(J)	(K)
		1,000	10,000	1,000	10,000

2. Recommended Plant Control Tests on a Monthly to Biannual basis in a typical STP

Sl. No.	Tests	Raw sewage	Outfall	Sludge cake
1	Mercury (Hg)	•	•	•
2	Lead (Pb)	•	•	•
3	Cadmium (Cd)		•	•
4	Hexavalent Chromium (Cr+6)		•	•
5	Total Chromium (Cr)		•	•
6	Copper (Cu)	•	•	•
7	Zinc (Zn)		•	•
8	Nickel (Ni)	•	•	•
9	Manganese (Mn)	•	•	•
10	Iron (Fe)	•	•	•
11	Vanadium (V)	•	•	•
12	Cyanide (CN)	•	•	•
13	Fluoride (F)	•	•	•
14	Phenolic compounds		•	•
15	Arsenic (As)	•	•	•
16	Selenium (Se)	•	•	•
17	Ca		•	
18	Mg		•	
19	Na		•	
20	K		•	
21	Chloride		•	
22	SO_4		•	
23	Alkalinity		•	
24	CO_2		•	
25	HCO_3		•	
26	Bio-assay test	•	•	•
27	Radioactive materials:	•	•	•
	(a) Alpha emitter	•	•	•
	(b) Beta emitter	•	•	•

3. Recommended Plant Control Tests on a Weekly basis in a typical STP

Sl. No.	Tests	Raw sewage	Aeration tank	Outfall	Sludge cake
1	BOD (Filtered)	•		•	
2	COD (Filtered)	•		•	
3	Microscopy (*)		•		
4	Faecal Coliform			•	
5	Total Coliform			•	
6	Oil and grease	•		•	•
7	Total residual chlorine			•	
8	Ammonical Nitrogen	•		•	
9	Total Kjeldahl Nitrogen	•		•	
10	Nitrate Nitrogen	•		•	
11	Free ammonia	•		•	
12	Dissolved Phosphates (P)	•		•	
13	Sulphate	•		•	
14	Chloride	•		•	
15	Silica	•		•	
16	Ca	•		•	
17	Mg	•		•	
18	TDS	•		•	
19	Conductivity	•		•	

4. Recommended Plant Control Tests on a Daily basis in a typical STP

Sl. No.	Tests	Raw sewage	Primary clarifier outlet	Aeration tank	Secondary clarifier outlet	Outfall	Primary sludge	Return sludge	Thickener underflow	Digested sludge	Sludge cake
1	Temperature	•	•	•	•	•		•		•	
2	pH	•	•	•	•	•	•	•	•	•	
3	Alkalinity	•	•		•			•		•	
4	BOD (total)	•	•		•	•					
5	COD (total)	•	•		•	•					
6	TSS	•	•		•	•					
7	VSS	•	•		•	•					
8	Residual Chlorine					•					
9	Moisture Content						•	•	•	•	•
10	MLSS			•							
11	MLVSS			•							
12	DO			•	•						
13	SV_{30}			•							
14	SVI			•							
15	Ammonia, Nessler	•		•		•					
16	Ortho P, Nessler	•		•		•					
17	Sulphide	•				•					

5. Used based classifications of surface waters in India

Class	Designated best use	Criteria	Limits
A	Drinking water source without conventional treatment but after disinfection	pH	6.5 to 8.5
		Dissolved Oxygen (D O)	6 or more
		BOD	2 or less
		Total Coliform MPN/ 100 ml	50 or less
B	Outdoor bathing (organized)	pH	6.5 to 8.5
		Dissolved Oxygen (D O)	5 or more
		BOD	3 or less
		Total Coliform MPN/ 100 ml	50 or less
C	Drinking water source with conventional treatment followed by disinfection	pH	6.5 to 8.5
		Dissolved Oxygen (D O)	4 or more
		BOD	3 or less
		Total Coliform MPN/ 100 ml	5000 or less
D	Propagation of wild life and fisheries	pH	6.5 to 8.5
		Dissolved Oxygen (D O)	4 or more
		Free Ammonia	1.2 mg/l or less
E	Irrigation, industrial cooling, and controlled waste disposal	pH	6.0 to 8.5
		Electrical Conductivity, micro mhos/cm	<2250
		Sodium Absorption Ratio (SAR)	<26
		Boron	<2 mg/l

ANNEXURE 16: Laboratory Staff Requirement (Indicative)

Computations for Staff Requirement:

Of the 65 surface water supply systems having treatment plant facilities, 33 WTPs at 19 locations have the total capacity > 7.5 mld and remaining 32 WTPs have capacity less than 7.5 mld. While an overall 90 towns depend on ground water sources, about 41 towns within these 90 towns are exclusively dependent on ground water sources.

Staff Requirement: Proposed Number of Personnel per each laboratory level as per recommendation of CPHEEO manual

Laboratory Level	Chief Analyst	Analyst Chemist	Analyst Micro-biologist	Analyst Bacterio-logist	Assistant Analyst Chemist	Assistant Bacteriologist	Assistant Biologist	Laboratory Assistant	Typist cum Clerk	Specimen Collector/ Lab. Attendant	Driver	Lab Cleaner /Sweeper	Total
State Laboratory*	√	√	√	√	0	√	√	√	√	√	√	√	
Upgraded Div. Laboratory*	√	√	√	√	0	√	√	√	0	√	√	√	
Divisional Laboratory*	√	√	0	√	√	0	0	√	0	√	√	√	
PHE Laboratory** (>7.5 mld)		1	1		0			3	1	3	0	3	12
PHE Laboratory** (<7.5 mld)		0	0		1			1	0	1	0	2	5
Other ULB								1		1		2	2

*Note: As per CPHEEO Manual, 2005 the level and number of personnel shall be decided by the respective agencies depending on the magnitude of problems and resources available.

**Note: As per CPHEEO Manual the numbers of personnel for a WTP level/PHE laboratory (up to 7.5 mld and above) are specified.

Estimated total Staff Requirement for all the laboratories

Laboratory Level	No. of laboratories	Chief Analyst	Analyst Chemist	Analyst Microbiologist	Analyst Bacteriologist	Assistant Analyst - Chemist	Assistant Bacteriologist	Assistant Biologist	Laboratory Assistant	Typist cum Clerk	Specimen Collector/ Lab. Attendant	Driver	Lab Cleaner /Sweeper	Total
State Laboratory	**1**	√	√	√	√	0	√	√	√	√	√	√	√	
Upgraded Division Laboratory	**4**	√	√	√	√	0	√	√	√	0	√	√	√	
Divisional Laboratory	**15**	√	√	0	√	√	0	0	√	0	√	√	√	
PHE Laboratory (>7.5 mld)	**19**	0	19	19	0	0	0	0	57	19	57	0	0	171
PHE Laboratory (<7.5 mld)	**32**	0	0	0	0	32	0	0	32	0	32	0	0	96
Other ULB	**44**								44		44			88
Total		**0**	**19**	**19**	**0**	**32**	**0**	**0**	**133**	**19**	**133**	**0**	**0**	**355**

The existing support staff (sweepers and drivers) of respective divisions shall be utilised at the laboratories and any additional requirement would be met through outsourcing.*Additional staff would be required to cater to the requirements of testing laboratories at sewage treatment plants and state/divisional laboratories for testing of treated waste water. Additional staff would also be required to set up dedicated teams for Quality Control units at the PH Divisions for undertaking Water Quality Surveillance activities, as per table below.

CPHEEO recommended norm for staff requirements at sewage treatment plants for testing of treated waste water:

Operating MLD of STP	5	10	20	60	100	150	200	250	300
Chemist	1	1	1	1	2	2	2	2	2
Micro Biologist								1	1
Lab Assistant	1	1	1	2	2	2	2	2	2

Staff requirements to be computed from the actual number of STP

Computation for Staff Requirement for Water Quality Surveillance - As per the recommendations of CPHEEO Manual

Laboratory Level		Senior Health Officer	Zonal Health Officer	Chief Health/Sanitary Inspector	Health/Sanitary Inspector	Chemist	Bacteriologist	Lab Assistant	Lab Attendant	Total
State Laboratory*										
Division Laboratory (>200 mld)** (5-10 lakh population)		1	1	1	1	1	1	1	1	8
Divisional Laboratory (>200 mld) (1-5 lakh population)			1		1	1		1	1	5
Basic/ PHE Laboratory					1			1	1	3

Total Staff Requirement for Water Quality Surveillance

Laboratory Level	No.	Senior Health Officer	Zonal Health Officer	Chief Health/Sanitary Inspector	Health/Sanitary Inspector	Chemist	Bacteriologist	Lab Assistant	Lab Attendant	Total
State Laboratory*	1	1	1	1	1	1	1	1	1	8
Division Laboratory (>200 mld) (5-10 lakh population	2	2	2	2	2	2	2	2	2	16
Divisional Laboratory (>200 mld) (1-5 lakh population)	5		5		5	5		5	5	25
Basic/ PHE Laboratory	12				12			12	12	36
Total										**85**

*Note: Staff as per existing State Medical and Health Department Norms

**Note: As per CPHEEO Manual, 2005 the l number of personnel shall be decided by the respective agencies depending on the magnitude of problems and resources available.

For periodical testing, samples shall be sent to District or State Health Laboratory

Basic/ PHE Laboratory-laboratory unit at P H Divisions

B. Computation for Staff Requirement - As per the proposed Water Quality Monitoring Protocol

Proposed Number of Personnel at each laboratory level

		Chief Analyst	Senior Analyst	Analyst	Assistant Analyst	Lab Assistant	Junior Laboratory Assistant	Typist cum Clerk	Specimen Collector/ Lab. Attendant	Sweeper	Computer Operator	**Total**
State Laboratory		1	3	4	3	6	0	1	8	0	2	28
Upgraded Division Lab		0	1	2	2	3	0	1	4	0	1	14
Divisional Laboratory		0	0	1	2	1	0	1	2	0	1	8
PHE Laboratory **(>7.5 mld)		0	0	1	0	1	0	0	2	0	0	4
PHE Laboratory** (<7.5 mld)		0	0	0	0	0	1	0	1	0		2
Other ULB							1					1

Senior Analysts includes one Senior Chemist, Senior Microbiologist and Senior Analyst (Sewage);
Analysts includes Analyst Chemist/Analyst Microbiologist/ Analyst (sewage);
Assistant Analysts includes Assistant Analyst Chemist/Bacteriologist/Microbiologist
**Note: As per CPHEEO Manual the numbers of personnel for a WTP level/PHE laboratory (up to 7.5 mld and above) are specified.

Total Staff Requirement for all the laboratories

	Number of Laboratories	Chief Analyst	Senior Analyst	Analyst	Assistant Analyst	Lab Assistant	Junior Laboratory Assistant	Typist cum Clerk	Specimen Collector/ Lab. Attendant	Sweeper	Computer Operator	**Total**
State Laboratory	**1**	1	3	4	3	6	0	1	8	0	2	28
Upgraded Division Lab	**4**	0	4	8	8	12	0	4	16	0	4	56
Divisional Laboratory	**15**	0	0	15	30	15	0	15	30	0	15	120
PHE Laboratory (>7.5 mld)	**19**	0	0	19	0	19	0	0	38	0	0	76
PHE Laboratory (<7.5 mld)	**32**	0	0	0	0	0	32	0	32	0	0	64
Other ULB	**44**						44					44
Total		**1**	**7**	**46**	**41**	**52**	**76**	**20**	**124**	**0**	**21**	**388**

*The existing support staff (sweepers and drivers) of respective PH divisions shall be utilised at the laboratories and any additional requirement would be met through outsourcing. The above proposed staff includes the staff requirement for Quality Testing of Treated Waste Water from STPs and other Water Quality Surveillance activities.

ANNEXURE 17: Educational Qualification of Laboratory Technical Staff

Recommended Minimum Educational Qualification:

a) Chief Analyst: He/ She must have possessed a Master's Degree in Chemistry, Zoology or Microbiology or an equivalent qualification from any University or Institution recognized by the Government with twenty years work experience in the field of water & waste water.

b) Senior Chemist, Senior microbiologist, Senior Analyst: He/ She must have possessed a Master's Degree in Chemistry, Zoology or Microbiology or an equivalent qualification from any University or Institution recognized by the Government with ten years work experience in the field of water & waste water

c) Analyst Chemist, Analyst Microbiologist: He/ She must have possessed a Master's Degree in Chemistry, Zoology or Microbiology or an equivalent qualification from any University or Institution recognized by the Government with five year work experience in the field of water & waste water

d) Assistant Analyst Chemist, Assistant Analyst Microbiologist: He/ She must have possessed a Master's Degree in Chemistry, Zoology or Microbiology or an equivalent qualification from any University or Institution recognized by the Government

e) Laboratory Assistant: He/ She must have possessed a Bachelor's Degree in Science with honours in Chemistry, Botany, and Zoology from any University or Institution recognized by the Government

f) Junior Laboratory Assistant: He/ She must have possessed a Bachelor's Degree in Science or an equivalent qualification from any University or Institution recognized by the Government.

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Specific Guidelines for Chemical Testing Laboratories (NABL 103):
The chemical testing laboratory shall be headed by a person preferably having a post graduate degree in chemistry or equivalent or Bachelor degree in chemical engineering / technology or equivalent with adequate experience in the relevant area especially in the analysis of testing of relevant products.

The minimum qualification for the technical staff in a chemical testing laboratory shall be Graduate in Science with chemistry as one of the subjects or Diploma in chemical engineering / technology or equivalent or specialization in relevant fields like Textile, Polymer etc. The staff shall have sufficient training and exposure in analytical chemistry and in analysis and testing of appropriate products. The laboratory technicians or equivalent shall have higher secondary certificate in science / ITI and at least one year experience or training in a relevant laboratory.

Specific Guidelines for Biological Testing Laboratories (NABL 102):
The minimum qualification for the technical staff in a biological testing laboratory shall be graduate in biology/ microbiology/fisheries/food science/food technology/ pharmaceutical sciences/biotechnology/ molecular biology/biochemistry/toxicology/veterinary science. Alternative qualifications in biological sciences may meet requirements where staff has relevant experience relating to the laboratory's scope of accreditation. Also refer (ISO/IEC 17025 clause 5.2).

Staff should have a minimum of 1 year of work experience in similar area covered by the scope of accreditation as proven by demonstrated competence on records. Freshers can be put under training with adequate supervision.