BEFORE THE NATIONAL GREEN TRIBUNAL (SOUTHERN ZONE) CHENNAI

OA NO. 13 OF 2021

Tribunal on its own motion-SUO MOTU Based on the News item in Deccan Chronicle English Newspaper, Dated 10.12.2020, "Kurnool shocked by quality of KMC water."

Versus

Union of India, Rep. by its Secretary Ministry of Environment, Forests and Climate Change, Indira Paryavaran Bhavan, Jorbagh Road, New Delhi 110 003 and 21 Others

RESPONDENTS

COUNTER FILED ON BEHALF OF RESPONDENT No.11, CENTRAL POLLUTION CONTROL BOARD (CPCB)

Advocate P. Jayalakshmi

COUNSEL FOR CPCB

BEFORE THE NATIONAL GREEN TRIBUNAL (SOUTHERN ZONE)
CHENNAI

ORIGINAL APPLICATION NO.13 OF 2021

IN THE MATTER OF:

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Indira ParyavaranBhavan,Jorbagh Road,
New Delhi 110 003 and 21 Others ……RESPONDENT(S)

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Signed and verified on this 16th day of March, 2021 at Chennai.

Deponent

H.D.VARALAXMI, M.Tech
Regional Director
CENTRAL POLLUTION CONTROL BOARD
(MoEF & CC. Govt of India)
Regional Directorate (Chennai)
2nd Floor, 77-A, South Avenue Road,
Ambattur Industrial Estate, Chennai - 600 058

Counsel for CPCB

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New Delhi 110 003 and 21 Others ……RESPONDENT(S)

AFFIDAVIT FILED ON BEHALF OF RESPONDENT No.11, CENTRAL POLLUTION CONTROL BOARD (CPCB) IN COMPLIANCE TO HON'BLE NGT ORDER DT. 23rd FEBRUARY, 2O21

I, H. D. Varalaxmi, D/o Shri H.S. Devaiah, Hindu, aged about 51 years and having office at the Regional Directorate – Chennai, Central Pollution Control Board, 2nd Floor, 77-A, Ambattur Industrial Estate, Chennai – 600 058, do hereby solemnly affirm and sincerely state as follows:-

1. That I am presently working as Scientist 'E' & holding Charge of Regional Director (Chennai), Central Pollution Control Board (hereafter called as CPCB) and have been authorized to file the counter affidavit on behalf of 11th respondent. I am fully conversant with the facts of the case and hence, competent and authorized to depose and swear the present as under:

2. Hon'ble NGT has Suo-Moto registered the case on the basis of the newspaper reports published in Deccan Chronicle dated 10.12.2020 under the caption" Kurnool Shocked by quality of KMC water" and another newspaper report published in Eenadu Telugu newspaper, Kurnool edition dated 27.12.2020 and another newspaper report published in Deccan Chronicle dated 05.01.2021 under the caption"10 fall ill after drinking contaminated water in Kosigi" complaining that the Tungabhadra river in that area has been polluted in Handri and Tungabhadra which flows across Tungabhadra which flows across Kurnool city due to discharge of untreated industrial effluents, untreated sewage and also dumping of municipal waste.

3. It is submitted that the Kurnool Municipal Corporation and Rural Water Supply Department, Govt. of Andhra Pradesh are entrusted with the responsibility of Drinking water supply. These departments have to ensure that quality and safe drinking water is supplied to the public.

4. It is submitted that Andhra Pradesh Pollution Control Board (APPCB) is empowered to grant Consent to Establish (CTE) and Consent to Operate (CTO) under the Water (Prevention and Control of Pollution) Act, 1974 and Air (Prevention & Control of Pollution) Act, 1981to the industries only after ensuring requisite facilities and also to ensure compliance of conditions of CTE & CTO to prevent air and water pollution. APPCB and other concerned authorities are required to take appropriate action against defaulting industries indulged in discharging untreated effluents into water bodies under the provisions of Environmental laws.

5. It is submitted that Local Panchayats, Kurnool Municipal Corporation, District Collectorate- Kurnool, and Commissioner and Director of Municipal Administration (CDMA), Govt. of Andhra Pradesh are responsible for maintenance of ghats, establishment and O&M of treatments plants for treatment of water & sewage. It is submitted that APPCB shall regularly monitor the water quality of the rivers and streams within the jurisdiction of the AP State and take appropriate remedial actions if the water quality is not meeting the designated best use of water.

   Further, it is pertinent to mention here that CPCB in association with APPCB is monitoring water quality of River Tungabhadra and River Hundri under National Water Quality Monitoring Programme at four and one locations respectively. Water quality of River Tungabhadra and River Hundri observed during year 2020 and year 2019 revealed that

   - River Tungabhadra: InYear 2020, out of four locations monitored, low Dissolved Oxygen levels were observed at Kurnool D/s and pH was not complying at Gondiparla, Kurnool. In Year 2019, low Dissolved Oxygen levels were observed at 2 locations (Gondiparla and D/s Kurnool). pH was not complying at one location (Manthralayam, Kurnool) w.r.t. Primary Water Quality Criteria for Bathing.

   - Water quality of River Hundri was complying to Primary Water Quality Criteria for Bathing during both Years 2019 and 2020 except one incidence in March 2020 where low Dissolved Oxygen levels were observed. Water quality data of River Tungabhadra and River Hundri for the year 2020 and 2019 is placed at **Annexure I**.

- The water quality of Rivers is required to be ensured for compliance to Primary Water Quality Criteria for Bathing notified under Environment (Protection) Amendment Rules, 1986 (**Annexure –II**). If the river water is used for drinking purposes after conventional treatment, the water quality should be ensured to comply to IS 10500:2012 Drinking Water Specifications (**Annexure –III**). For any other purposes, compliance to Use based classification of surface waters in India be ensured (**Annexure –IV**).

6. It is submitted that Municipalities and Directorate of Municipal Administration are responsible for solid waste collection, transportation, treatment and disposal in accordance with Solid Waste Management Rules, 2016. State health department is required to carry out assessment of health impacts specially in Kosigi village due to improper drinking water supply. Municipal Corporations, District Collectorate, Rural Water Supply Department, Commissioner & Director of Municipal Administration (ULBs) and APPCB are the regulatory Authorities for ensuring safe drinking water supply and Prevention of river pollution in the State.

7. It is submitted that APPCB and other concerned authorities in the AP State are required to take appropriate action against discharge of untreated municipal sewage & industrial effluents into river, dumping of waste such as solid waste and bio-medical waste into the river bodies under the provisions of Solid Waste Management Rules, 2016 and Bio-medical Waste Management Rules, 2016 notified under the Environment (Protection) Act, 1986 and amendments thereof.

   It is pertinent to mention here that based on water quality monitoring carried out in the years 2016 and 2017, CPCB identified 351 polluted river stretches in the Country considering the criteria pollutant, Biochemical Oxygen Demand (BOD) for the exercise. In Andhra Pradesh State, 05 stretches were identified as polluted and categorized in Priorities III to V including Polluted River Stretch of River Tungabhadra from Manthralayam to Bavapuram in Priority IV class (maximum BOD ranging between 6 and 10 mg/L).

   Hon'ble NGT vide orders passed in OA No 673/2018 in the matter of News item published in 'THE HINDU' titled "More river stretches are now critically polluted: CPCB" directed all the concerned State Governments and UT Administrations to prepare action plans for restoration of identified Polluted River Stretches and execution of approved action plans by 30.6.2021 for bringing all the polluted river stretches to be fit at least for bathing purposes (i.e. BOD < 3 mg/L and FC < 500 MPN/100 mL). The action plans for rejuvenation of identified polluted river stretch of River Tungabhadra (within Andhra Pradesh State) have already been approved by CPCB Task Team.

.Presently, the status of implementation of Action Plans approved by CPCB Task Team in respect of P-I to P-IV prioritized polluted river stretches is being reviewed by the River Rejuvenation Committee constituted by respective State Govt/ UT Administration at State level, while the Central Monitoring Committee (CMC) constituted by Hon'ble NGT under the chairmanship of Secretary, Ministry of Jal Shakti (MoJS) reviews the progress at Central level, periodically.

PRAYER

Hence. it is respectfully prayed that CPCB may be exempted from the list of respondents. However, CPCB is committed to abide by the order/directions, passed by the Hon'ble Tribunal.

Deponent

H.D. VARALAXMI, M.Tech
Regional Director
CENTRAL POLLUTION CONTROL BOARD
(MoEF & CC. Govt of India)
Regional Directorate (Chennai)
2nd Floor, 77-A, South Avenue Road,
Ambattur Industrial Estate, Chennai - 600 058

VERIFICATION

It is verified that the content of this Affidavit is based on official record and information available in the office are true and correct. Nothing has been concealed therein.

Signed and verified on this 16th day of March, 2021 at Chennai

Deponent

H.D. VARALAXMI, M.Tech
Regional Director
CENTRAL POLLUTION CONTROL BOARD
(MoEF & CC. Govt of India)
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2nd Floor, 77-A, South Avenue Road,
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Counsel for CPCB

Annexure –I

Water Quality Data of River Tungabhadra in Year 2020

S N.	Name Of Monitoring Location	Temperature °C		DO mg/L		pH		Conductivity µmhos/cm		BOD mg/L		NitrateN+NitriteN mg/L		Fecal Coliform MPN/100mL		Total Coliform MPN/100mL	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1	Kurnool U/s, Bhavapuram, Kurnool	20	28	5.4	6.6	7.3	8.2	602	1730	1.3	3	0.33	2.54	95	300	400	1200
2	At Manthralayam, Kurnool	21	29	5.3	6.6	6.9	7.9	361	1611	1.4	2.8	0.46	2.49	94	400	400	1500
3	U/s Kurnool, Gondiparla, Kurnool	21	27	5.1	6.4	6.2	8	629	2948	1	3	0.56	6.8	76	300	400	1200
4	D/s Kurnool	21	28	4.3	6	7	8	706	1943	0.8	2.8	0.48	3	100	300	400	1500

S N.	Name Of Monitoring Location	Turbidity NTU		Phenolphthalein Alkalinity mg/L		Total Alkalinity mg/L		Chloride mg/L		COD mg/L		Total Kjeldahl Nitrogen mg/L		Ammonia N mg/L		Total Hardness mg/L	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1	Kurnool U/s, Bhavapuram, Kurnool	1.6	16	0.1	20	116	241	80	283	10	22	0.3	4.5	0.2	2.8	128	268
2	At Manthralayam, Kurnool	1.7	71	0.1	0.1	98	264	56	222	10	23	0.8	4.8	0.5	2.5	102	260
3	U/s Kurnool, Gondiparla, Kurnool	2.1	28	0.1	6	131	272	105	853	12	22	1.1	9	0.5	7.6	152	660
4	D/s Kurnool	3.2	45.3	0.1	10	170	437	71	363	10	24	0.8	6.4	0.6	5.3	150	414

S N.	Name Of Monitoring Location	Calcium mg/L		Magnesium mg/L		Sulphate mg/L		Sodium mg/L		Total Dissolved Solids mg/L		Boron mg/L		Potassium mg/L		Fluoride mg/L	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1	Kurnool U/s, Bhavapuram, Kurnool	56	164	44	163	79	286	92	310	421	1210	0.8	3.1	3	7.3	0.4	2
2	At Manthralayam, Kurnool	53	156	36	197	28	271	49	275	253	1120	1.1	2.6	3	7.1	0.2	0.9
3	U/s Kurnool, Gondiparla, Kurnool	78	314	48	388	53	300	82	440	424	2010	1	2.9	3.5	32	0.3	1.1
4	D/s Kurnool	78	215	62	224	55	184	91	336	424	1328	1.1	2.9	3.4	15	0.2	1.5

S N.	Name Of Monitoring Location	Sodium Percentage		SAR		Ortho Phosphate mg/L	
		Min	Max	Min	Max	Min	Max
1	Kurnool U/s, Bhavapuram, Kurnool	53	73	3.1	8.2	0.02	0.9
2	At Manthralayam, Kurnool	50	70	2.1	7.4	0.02	0.9
3	U/s Kurnool, Gondiparla, Kurnool	50	69	2.7	7.9	0.06	0.9
4	D/s Kurnool	55	67	3.2	7.4	0.1	1.3

Water Quality Data of River Tungabhadra in Year 2019

S N.	Name Of Monitoring Location	Temperature °C		DO mg/L		pH		Conductivity µmhos/cm		BOD mg/L		NitrateN+NitriteN mg/L		Fecal Coliform MPN/100mL		Total Coliform MPN/100mL	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1	Kurnool U/s, Bhavapuram, Kurnool	18	26	5.4	7.1	6.8	8.1	226	1598	1	2.8	0.62	1.93	1.8	100	300	800
2	At Manthralayam, Kurnool	17	26	5.2	7	6.2	7.9	261	1403	0.8	2.8	0.24	2.3	100	200	300	1000
3	U/s Kurnool, Gondiparla, Kurnool	21	27	4.1	6.8	7.1	7.8	275	2023	1.2	2.8	1.14	11	1.8	200	300	1100
4	D/s Kurnool	23	26	4.4	6.8	7.1	7.8	271	2176	1	2.8	0.72	9.8	100	200	300	1400

S N.	Name Of Monitoring Location	Turbidity NTU		Total Alkalinity mg/L		Chloride mg/L		COD mg/L		Total Kjeldahl Nitrogen mg/L		Ammonia N mg/L		Total Hardness mg/L		Calcium mg/L	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1	Kurnool U/s, Bhavapuram, Kurnool	2	21	62	301	21	248	7	28	0	1.4	0	1.4	76	307	54	158
2	At Manthralayam, Kurnool	3.1	34	66	220	22	162	7	22	0.4	1.4	0	1	80	245	50	132
3	U/s Kurnool, Gondiparla, Kurnool	2	46	58	311	38	445	9	24	0.6	1.4	0	0.8	76	320	56	198
4	D/s Kurnool	3.6	42	64	361	24	545	8	24	0.8	1.4	0.6	1.1	90	339	42	141

S N.	Name Of Monitoring Location	Magnesium mg/L		Sulphate mg/L		Sodium mg/L		Total Dissolved Solids mg/L		Boron mg/L		Potassium mg/L		Fluoride mg/L		Sodium Percentage	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1	Kurnool U/s, Bhavapuram, Kurnool	22	159	17	232	16	243	129	947	0	2.4	2	11	0.1	1.1	31	70
2	At Manthralayam, Kurnool	30	137	27	263	23	230	144	866	0.2	2.8	2.4	5	0.3	1.2	38	71
3	U/s Kurnool, Gondiparla, Kurnool	20	135	20	186	27	322	159	1416	0.19	2.6	2.5	45	0.1	1.4	42	65.2
4	D/s Kurnool	48	214	32	185	19	406	152	1520	0.13	2.9	2.6	22	0.1	1.2	31	70.4

S N.	Name Of Monitoring Location	SAR		Ortho Phosphate mg/L	
		Min	Max	Min	Max
1	Kurnool U/s, Bhavapuram, Kurnool	0.8	7.1	0	0.2
2	At Manthralayam, Kurnool	1.1	7.1	0	0.6
3	U/s Kurnool, Gondiparla, Kurnool	1.3	7.9	0.01	0.3
4	D/s Kurnool	0.9	9.5	0.04	1.1

Water Quality Data of River Hundri at Joharapuram, Kurnool in Year 2020

Sampling* Month	Sampling Date	Temperature °C	DO mg/L	pH	Conductivity µmhos/cm	BOD mg/L	NitrateN mg/L	NitriteN mg/L	Fecal Coliform MPN/100mL	Total Coliform MPN/100mL	Turbidity NTU	Total Alkalinity mg/L	Chloride mg/L
Jan	09-01-2020	26	5.4	7.6	820	2	0.7	0.1	200	900	4	216	106
Feb	10-02-2020	25	6.4	7.8	730	2	1.3	0.54	100	700	4.3	229	112
Mar	03-03-2020	30	4.7	7.5	1196	2.8	1.2	0.1	100	700	21.7	215	230
Jul	08-07-2020	25	5.2	7.5	1350	2.6	1.8	0.09	200	800	24	304	140
Aug	01-08-2020	25	5.8	7.6	910	2.7	0.5	0.06	100	600	21	264	102
Sep	04-09-2020	24	6.1	7.4	876	1.5	2	0.3	200	700	18.9	228	112
Oct	15-10-2020	22	6.4	7.8	830	1.7	1.8	0.37	100	600	15	236	80
Nov	11-11-2020	23	5.9	7.6	956	2.2	1.9	0.34	84	280	4.1	260	112
Dec	08-12-2020	22	5.6	8.2	996	2.3	1.7	0.51	120	540	4	222	117

Sampling* Month	Sampling Date	COD mg/L	Total Kjeldahl Nitrogen mg/L	Ammonia N mg/L	Total Hardness mg/L	Calcium mg/L	Magnesium mg/L	Sulphate mg/L	Sodium mg/L	Total Dissolved Solids mg/L	Boron mg/L	Potassium mg/L	Fluoride mg/L
Jan	09-01-2020	17	1.4	1.1	204	112	92	104	126	564	2.3	5.2	0.9
Feb	10-02-2020	16	0.6	0.1	181	36	145	59	124	510	1.8	3.8	0.5
Mar	03-03-2020	24	2.8	1.7	270	131	139	140	192	824	2.1	7.9	0.4
Jul	08-07-2020	12	1.1	0.1	204	144	60	136	204	810	0.8	6.4	1.2
Aug	01-08-2020	13	1.2	0.1	228	140	88	56	109	553	1.1	6	1
Sep	04-09-2020	12	7.8	5.6	220	120	100	108	130	612	1.4	4.6	0.7
Oct	15-10-2020	14	3.9	3.1	170	60	110	50	107	498	2.6	5.5	0.2
Nov	11-11-2020	17	3.4	2	272	140	132	69	102	574	1.8	4.9	0.3
Dec	08-12-2020	18	3.6	1.7	204	98	106	91	129	573	1.9	5	0.5

Sampling* Month	Sampling Date	Sodium Percentage	SAR	Ortho Phosphate mg/L
Jan	09-01-2020	57	3.8	0.1
Feb	10-02-2020	59	4	0.03
Mar	03-03-2020	60	5.1	0.3
Jul	08-07-2020	67.8	6.2	0.14
Aug	01-08-2020	50.19	3.1	0.4
Sep	04-09-2020	56	3.8	0.1
Oct	15-10-2020	57	3.6	0.4
Nov	11-11-2020	44	2.7	0.28
Dec	08-12-2020	57.12	3.93	0.36

NA- Not Analysed

***sampling not conducted in months - April, May and June, 2020**

Water Quality Data of River Hundri at Joharapuram, Kurnool in Year 2019

Sampling Month*	Sampling Date	Temperature °C	DO mg/L	pH	Conductivity µmhos/cm	BOD mg/L	NitrateN mg/L	NitriteN mg/L	Fecal Coliform MPN/100mL	Total Coliform MPN/100mL	Turbidity NTU	Total Alkalinity mg/L
Jan	03-01-2019	18	6.2	7.8	1389	2.2	1.3	0.4	100	800	15.6	258
Feb	07-02-2019	19	5.6	7.2	1020	1.8	1.7	0.18	100	600	10.9	173
Mar	06-03-2019	21	5.5	7.6	1180	2.8	2.6	0.2	100	600	11.4	197
Sep	13-09-2019	22	6.5	7.3	587	1.2	0.9	0.05	NA	500	20	146
Oct	09-10-2019	23	6.6	7.8	671	1.8	1.4	0.2	1.8	500	18	144
Nov	19-11-2019	24	5.9	7.6	828	1.7	1.3	0.3	100	500	8	232
Dec	17-12-2019	25	5.9	7.6	954	1.3	2.5	0.1	100	800	13	236

Sampling Month*	Sampling Date	Chloride mg/L	COD mg/L	Total Kjeldahl Nitrogen mg/L	Ammonia N mg/L	Total Hardness mg/L	Calcium mg/L	Magnesium mg/L	Sulphate mg/L	Sodium mg/L	Total Dissolved Solids mg/L	Boron mg/L
Jan	03-01-2019	181	17	1	1	239	106	133	166	203	837	0.2
Feb	07-02-2019	135	16	1.4	0.8	158	83	75	138	163	621	0.3
Mar	06-03-2019	142	24	1.1	0.8	192	96	96	181	184	721	0.4
Sep	13-09-2019	62	9	1.1	0.6	136	82	54	54	71	343	0.27
Oct	09-10-2019	76	16	0.6	0	176	104	72	84	76	403	1.1
Nov	19-11-2019	76	14	1.1	0.6	188	116	72	64	103	477	1.8
Dec	17-12-2019	132	12	0.8	0.6	232	76	156	127	154	668	1.7

Sampling Month*	Sampling Date	Potassium mg/L	Fluoride mg/L	Sodium Percentage	SAR	Ortho Phosphate mg/L
Jan	03-01-2019	14.9	0.9	63	5.7	0
Feb	07-02-2019	6.4	0.9	68	5.6	0.1
Mar	06-03-2019	5	0.5	67	5.8	0.2
Sep	13-09-2019	4.7	0.4	52	2.6	0.03
Oct	09-10-2019	3.6	0.6	48	2.5	0.08
Nov	19-11-2019	3.2	0.3	54	3.3	0.08
Dec	17-12-2019	2.4	0.8	59	4.4	0.1

NA- Not Analysed
***sampling not conducted in months - April, May, June, July and August, 2020**

Annexure –II

Use based classification of surface waters in India during 1979

DESIGNATED-BEST-USE	CLASS OF WATER	CRITERIA
Drinking Water Source without conventional treatment but after disinfection	A	Total Coliforms Organism MPN/100ml shall be 50 or less pH between 6.5 and 8.5 Dissolved Oxygen 6mg/L or more Biochemical Oxygen Demand 5 days 20°C 2mg/L or less
Outdoor bathing (Organised)	B	Total Coliforms Organism MPN/100ml shall be 500 or less pH between 6.5 and 8.5 Dissolved Oxygen 5mg/L or more Biochemical Oxygen Demand 5 days 20°C 3mg/L or less
Drinking water source after conventional treatment and disinfection	C	Total Coliforms Organism MPN/100ml shall be 5000 or less pH between 6 to 9 Dissolved Oxygen 4mg/L or more Biochemical Oxygen Demand 5 days 20°C 3mg/L or less
Propagation of Wild life and Fisheries	D	pH between 6.5 to 8.5 Dissolved Oxygen 4mg/L or more Free Ammonia (as N) 1.2 mg/L or less
Irrigation, Industrial Cooling, Controlled Waste disposal	E	pH between 6.0 to 8.5 Electrical Conductivity at 25°C micro mhos/cm Max.2250 Sodium absorption Ratio Max. 26 Boron Max. 2mg/L

Annexur-III

IS 10500 : 2012

भारतीय मानक

पीने का पानी — विशिष्टि

(दूसरा पुनरीक्षण)

Indian Standard

DRINKING WATER — SPECIFICATION

(Second Revision)

ICS 13.060.20

© BIS 2012

B U R E A U O F I N D I A N S T A N D A R D S
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

May 2012 **Price Group 6**

Drinking Water Sectional Committee, FAD 25

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Drinking Water Sectional Committee had been approved by the Food and Agriculture Division Council.

This standard was originally published in 1983. A report prepared by the World Health Organization in cooperation with the World Bank showed that in 1975, some 1 230 million people were without safe water supplies. These appalling facts were central to the United Nations decision to declare an International Drinking Water Supply and Sanitation decade, beginning in 1981. Further, the VI Five-Year Plan of India had made a special provision for availability of safe drinking water for the masses. Therefore, the standard was formulated with the objective of assessing the quality of water resources, and to check the effectiveness of water treatment and supply by the concerned authorities.

The first revision was undertaken to take into account the up-to-date information available about the nature and effect of various contaminants as also the new techniques for identifying and determining their concentration. Based on experience gained additional requirements for alkalinity; aluminium and boron were incorporated and the permissible limits for dissolved solids, nitrate and pesticides residues modified.

As per the eleventh five year plan document of India (2007-12), there are about 2.17 lakh quality affected habitations in the country with more than half affected with excess iron, followed by fluoride, salinity, nitrate and arsenic in that order. Further, approximately, 10 million cases of diarrhoea, more than 7.2 lakh typhoid cases and 1.5 lakh viral hepatitis cases occur every year a majority of which are contributed by unclean water supply and poor sanitation. The eleventh five year plan document of India (2007-2012) recognizes dealing with the issue of water quality as a major challenge and aims at addressing water quality problems in all quality affected habitations with emphasis on community participation and awareness campaigns as well as on top most priority to water quality surveillance and monitoring by setting up of water quality testing laboratories strengthened with qualified manpower, equipments and chemicals.

The second revision was undertaken to upgrade the requirements of the standard and align with the internationally available specifications on drinking water. In this revision assistance has been derived from the following:

a) EU Directives relating to the quality of water intended for human consumption (80/778/EEC) and Council Directive 98/83/EC.

b) USEPA standard — National Primary Drinking Water Standard. EPA 816-F-02-013 dated July, 2002.

c) WHO Guidelines for Drinking Water Quality. 3rd Edition Vol. 1 Recommendations, 2008.

d) Manual on Water Supply and Treatment, third edition — revised and updated May 1999, Ministry of Urban Development, New Delhi.

This standard specifies the acceptable limits and the permissible limits in the absence of alternate source. It is recommended that the acceptable limit is to be implemented as values in excess of those mentioned under 'Acceptable' render the water not suitable. Such a value may, however, be tolerated in the absence of an alternative source. However, if the value exceeds the limits indicated under 'permissible limit in the absence of alternate source' in col 4 of Tables 1 to 4, the sources will have to be rejected.

Pesticide residues limits and test methods given in Table 5 are based on consumption pattern, persistence and available manufacturing data. The limits have been specified based on WHO guidelines, wherever available. In cases where WHO guidelines are not available, the standards available from other countries have been examined and incorporated, taking in view the Indian conditions.

In this revision, additional requirements for ammonia, chloramines, barium, molybdenum, silver, sulphide, nickel, polychlorinated biphenyls and trihalomethanes have been incorporated while the requirements for colour, turbidity, total hardness, free residual chlorine, iron, magnesium, mineral oil, boron, cadmium, total arsenic, lead, polynuclear aromatic hydrocarbons, pesticides and bacteriological requirements have been modified.

In this revision, requirement and test method for virological examination have been included. Further, requirements and test methods for cryptosporidium and giardia have also been specified.

Routine surveillance of drinking water supplies should be carried out by the relevant authorities to understand the risk of specific pathogens and to define proper control procedures. The WHO Guidelines for Drinking Water Quality, 3rd Edition, Vol. 1 may be referred for specific recommendations on using a water safety approach incorporating risk identification. Precautions/Care should be taken to prevent contamination of drinking water from chlorine resistant parasites such as cryptosporidium species and giardia.

Indian Standard

DRINKING WATER — SPECIFICATION

(Second Revision)

1 SCOPE

This standard prescribes the requirements and the methods of sampling and test for drinking water.

2 REFERENCES

The standards listed in Annex A contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex A.

3 TERMINOLOGY

For the purpose of this standard the following definition shall apply.

3.1 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.

4 REQUIREMENTS

Drinking water shall comply with the requirements given in Tables 1 to 4. The analysis of pesticide residues given in Table 3 shall be conducted by a recognized laboratory using internationally established test method meeting the residue limits as given in Table 5.

Drinking water shall also comply with bacteriological requirements (*see* **4.1**), virological requirements (*see* **4.2**) and biological requirements (*see* **4.3**).

4.1 Bacteriological Requirements

4.1.1 *Water in Distribution System*

Ideally, all samples taken from the distribution system including consumers' premises, should be free from coliform organisms and the following bacteriological quality of drinking water collected in the distribution system, as given in Table 6 is, therefore specified when tested in accordance with IS 1622.

4.2 Virological Requirements

4.2.1 Ideally, all samples taken from the distribution

Table 1 Organoleptic and Physical Parameters
(*Foreword* and *Clause* 4)

Sl No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Method of Test, Ref to Part of IS 3025	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
i)	Colour, Hazen units, *Max*	5	15	Part 4	Extended to 15 only, if toxic substances are not suspected in absence of alternate sources
ii)	Odour	Agreeable	Agreeable	Part 5	a) Test cold and when heated b) Test at several dilutions
iii)	*p*H value	6.5-8.5	No relaxation	Part 11	—
iv)	Taste	Agreeable	Agreeable	Parts 7 and 8	Test to be conducted only after safety has been established
v)	Turbidity, NTU, *Max*	1	5	Part 10	—
vi)	Total dissolved solids, mg/l, *Max*	500	2 000	Part 16	—

NOTE — It is recommended that the acceptable limit 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 col 4, above which the sources will have to be rejected.

Table 2 General Parameters Concerning Substances Undesirable in Excessive Amounts
(*Foreword* and *Clause* 4)

Sl No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Method of Test, Ref to	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
i)	Aluminium (as Al), mg/l, *Max*	0.03	0.2	IS 3025 (Part 55)	—
ii)	Ammonia (as total ammonia-N), mg/l, *Max*	0.5	No relaxation	IS 3025 (Part 34)	—
iii)	Anionic detergents (as MBAS) mg/l, *Max*	0.2	1.0	Annex K of IS 13428	—
iv)	Barium (as Ba), mg/l, *Max*	0.7	No relaxation	Annex F of IS 13428* or IS 15302	—
v)	Boron (as B), mg/l, *Max*	0.5	1.0	IS 3025 (Part 57)	—
vi)	Calcium (as Ca), mg/l, *Max*	75	200	IS 3025 (Part 40)	—
vii)	Chloramines (as Cl_2), mg/l, *Max*	4.0	No relaxation	IS 3025 (Part 26)* or APHA 4500-Cl G	—
viii)	Chloride (as Cl), mg/l, *Max*	250	1 000	IS 3025 (Part 32)	—
ix)	Copper (as Cu), mg/l, *Max*	0.05	1.5	IS 3025 (Part 42)	—
x)	Fluoride (as F) mg/l, *Max*	1.0	1.5	IS 3025 (Part 60)	—
xi)	Free residual chlorine, mg/l, *Min*	0.2	1	IS 3025 (Part 26)	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
xii)	Iron (as Fe), mg/l, *Max*	0.3	No relaxation	IS 3025 (Part 53)	Total concentration of manganese (as Mn) and iron (as Fe) shall not exceed 0.3 mg/l
xiii)	Magnesium (as Mg), mg/l, *Max*	30	100	IS 3025 (Part 46)	—
xiv)	Manganese (as Mn), mg/l, *Max*	0.1	0.3	IS 3025 (Part 59)	Total concentration of manganese (as Mn) and iron (as Fe) shall not exceed 0.3 mg/l
xv)	Mineral oil, mg/l, *Max*	0.5	No relaxation	Clause **6** of IS 3025 (Part 39) Infrared partition method	—
xvi)	Nitrate (as NO_3), mg/l, *Max*	45	No relaxation	IS 3025 (Part 34)	—
xvii)	Phenolic compounds (as C_6H_5OH), mg/l, *Max*	0.001	0.002	IS 3025 (Part 43)	—
xviii)	Selenium (as Se), mg/l, *Max*	0.01	No relaxation	IS 3025 (Part 56) or IS 15303*	—
xix)	Silver (as Ag), mg/l, *Max*	0.1	No relaxation	Annex J of IS 13428	—
xx)	Sulphate (as SO_4) mg/l, *Max*	200	400	IS 3025 (Part 24)	May be extended to 400 provided that Magnesium does not exceed 30
xxi)	Sulphide (as H_2S), mg/l, *Max*	0.05	No relaxation	IS 3025 (Part 29)	—
xxii)	Total alkalinity as calcium carbonate, mg/l, *Max*	200	600	IS 3025 (Part 23)	—
xxiii)	Total hardness (as $CaCO_3$), mg/l, *Max*	200	600	IS 3025 (Part 21)	—
xxiv)	Zinc (as Zn), mg/l, *Max*	5	15	IS 3025 (Part 49)	—

NOTES

1 In case of dispute, the method indicated by '*' shall be the referee method.

2 It is recommended that the acceptable limit 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 col 4, above which the sources will have to be rejected.

Table 3 Parameters Concerning Toxic Substances
(*Foreword* and *Clause* 4)

Sl No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Method of Test, Ref to	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
i)	Cadmium (as Cd), mg/l, *Max*	0.003	No relaxation	IS 3025 (Part 41)	—
ii)	Cyanide (as CN), mg/l, *Max*	0.05	No relaxation	IS 3025 (Part 27)	—
iii)	Lead (as Pb), mg/l, *Max*	0.01	No relaxation	IS 3025 (Part 47)	—
iv)	Mercury (as Hg), mg/l, *Max*	0.001	No relaxation	IS 3025 (Part 48)/ Mercury analyser	—
v)	Molybdenum (as Mo), mg/l, *Max*	0.07	No relaxation	IS 3025 (Part 2)	—
vi)	Nickel (as Ni), mg/l, *Max*	0.02	No relaxation	IS 3025 (Part 54)	—
vii)	Pesticides, µg/l, *Max*	See Table 5	No relaxation	See Table 5	—
viii)	Polychlorinated biphenyls, mg/l, *Max*	0.000 5	No relaxation	ASTM 5175*	— or APHA 6630
ix)	Polynuclear aromatic hydro-carbons (as PAH), mg/l, *Max*	0.000 1	No relaxation	APHA 6440	—
x)	Total arsenic (as As), mg/l, *Max*	0.01	0.05	IS 3025 (Part 37)	—
xi)	Total chromium (as Cr), mg/l, *Max*	0.05	No relaxation	IS 3025 (Part 52)	—
xii)	Trihalomethanes:				
	a) Bromoform, mg/l, *Max*	0.1	No relaxation	ASTM D 3973-85* or APHA 6232	—
	b) Dibromochloromethane, mg/l, *Max*	0.1	No relaxation	ASTM D 3973-85* or APHA 6232	—
	c) Bromodichloromethane, mg/l, *Max*	0.06	No relaxation	ASTM D 3973-85* or APHA 6232	—
	d) Chloroform, mg/l, *Max*	0.2	No relaxation	ASTM D 3973-85* or APHA 6232	—

NOTES

1 In case of dispute, the method indicated by '*' shall be the referee method.

2 It is recommended that the acceptable limit 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 col 4, above which the sources will have to be rejected.

Table 4 Parameters Concerning Radioactive Substances
(*Foreword* and *Clause* 4)

Sl No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Method of Test, Ref to Part of IS 14194	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
i)	Radioactive materials:				
	a) Alpha emitters Bq/l, *Max*	0.1	No relaxation	Part 2	—
	b) Beta emitters Bq/l, *Max*	1.0	No relaxation	Part 1	—

NOTE — It is recommended that the acceptable limit 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 col 4, above which the sources will have to be rejected.

Table 5 Pesticide Residues Limits and Test Method
(*Foreword* and *Table* 3)

Sl No.	Pesticide	Limit µg/l	Method of Test, Ref to	
			USEPA	AOAC/ ISO
(1)	(2)	(3)	(4)	(5)
i)	Alachlor	20	525.2, 507	—
ii)	Atrazine	2	525.2, 8141 A	—
iii)	Aldrin/ Dieldrin	0.03	508	—
iv)	Alpha HCH	0.01	508	—
v)	Beta HCH	0.04	508	—
vi)	Butachlor	125	525.2, 8141 A	—
vii)	Chlorpyriphos	30	525.2, 8141 A	—
viii)	Delta HCH	0.04	508	—
ix)	2,4- Dichlorophenoxyacetic acid	30	515.1	—
x)	DDT (*o, p* and *p, p* – Isomers of DDT, DDE and DDD)	1	508	AOAC 990.06
xi)	Endosulfan (alpha, beta, and sulphate)	0.4	508	AOAC 990.06
xii)	Ethion	3	1657 A	—
xiii)	Gamma — HCH (Lindane)	2	508	AOAC 990.06
xiv)	Isoproturon	9	532	—
xv)	Malathion	190	8141 A	—
xvi)	Methyl parathion	0.3	8141 A	ISO 10695
xvii)	Monocrotophos	1	8141 A	—
xviii)	Phorate	2	8141 A	—

NOTE — Test methods are for guidance and reference for testing laboratory. In case of two methods, USEPA method shall be the reference method.

Table 6 Bacteriological Quality of Drinking Water[1)]
(*Clause* 4.1.1)

Sl No.	Organisms	Requirements
(1)	(2)	(3)
i)	*All water intended for drinking*:	
	a) *E. coli* or thermotolerant coliform bacteria[2), 3)]	Shall not be detectable in any 100 ml sample
ii)	*Treated water entering the distribution system*:	
	a) *E. coli* or thermotolerant coliform bacteria[2)]	Shall not be detectable in any 100 ml sample
	b) Total coliform bacteria	Shall not be detectable in any 100 ml sample
iii)	*Treated water in the distribution system*:	
	a) *E. coli* or thermotolerant coliform bacteria	Shall not be detectable in any 100 ml sample
	b) Total coliform bacteria	Shall not be detectable in any 100 ml sample

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

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

[3)]It is recognized that, in the great majority of rural water supplies in developing countries, faecal contamination is widespread. Under these conditions, the national surveillance agency should set medium-term targets for progressive improvement of water supplies.

system including consumers' premises, should be free from virus.

4.2.2 None of the generally accepted sewage treatment methods yield virus-free effluent. Although a number of investigators have found activated sludge treatment to be superior to trickling filters from this point of view, it seems possible that chemical precipitation methods will prove to be the most effective.

4.2.3 Virus can be isolated from raw water and from springs, enterovirus, reovirus, and adenovirus have been found in water, the first named being the most resistant to chlorination. If enterovirus are absent from chlorinated water, it can be assumed that the water is safe to drink. Some uncertainty still remains about the virus of infectious hepatitis, since it has not so far been isolated but in view of the morphology and resistance of enterovirus it is likely that, if they have been inactivated hepatitis virus will have been inactivated also.

4.2.4 An exponential relationship exists between the rate of virus inactivation and the redox potential. A redox potential of 650 mV (measured between platinum and calomel electrodes) will cause almost instantaneous inactivation of even high concentrations of virus. Such a potential can be obtained with even a low concentration of free chlorine, but only with an extremely high concentration of combined chlorine. This oxidative inactivation may be achieved with a number of other oxidants also, for example, iodine, ozone and potassium permanganate, but the effect of the oxidants will always be counteracted, if reducing components, which are mainly organic, are present. As a consequence, the sensitivity of virus towards disinfectants will depend on the *milieu* just as much as on the particular disinfectant used.

4.2.5 Viruses are generally resistant to disinfectants as well as get protected on account of presence of particulate and organic matter in water. Because the difference between the resistance of coliform organisms and of virus to disinfection by oxidants increases with increasing concentration of reducing components, for example, organic matter, it cannot be assumed that the absence of available coliform organisms implies freedom from active virus under circumstances where a free chlorine residual cannot be maintained. Sedimentation and slow sand filtration in themselves may contribute to the removal of virus from water.

4.2.6 In practice, >0.5 mg/l of free chlorine for 1 h is sufficient to inactivate virus, even in water that was originally polluted provided the water is free from particulates and organic matter.

4.2.7 MS2 phage are indicator of viral contamination in drinking water. MS2 phage shall be absent in 1 litre of water when tested in accordance with USEPA method 1602. If MS2 phage are detected in the drinking water, virological examination shall be done by the Polymerase Chain Reaction (PCR) method for virological examination as given in Annex B. USEPA method in Manual of Method for Virology Chapter 16, June 2001 shall be the alternate method. If viruses are detected, the cause shall be determined by immediate further investigation.

4.3 Biological Requirements

4.3.1 Ideally, all samples taken including consumers premises should be free from biological organisms. Biological examination is of value in determining the causes of objectionable tastes and odours in water and controlling remedial treatments, in helping to interpret the results of various chemical analysis, and in explaining the causes of clogging in distribution pipes and filters. In some instances, it may be of use in demonstrating that water from one source has been mixed with that from another.

4.3.2 The biological qualities of water are of greater importance when the supply has not undergone the conventional flocculation and filtration processes, since increased growth of methane-utilizing bacteria on biological slimes in pipes may then be expected, and the development of bryozoal growths such as *Plumatella* may cause operational difficulties.

4.3.3 Some of the animalcules found in water mains may be free-living in the water, but others such as *Dreissena* and *Asellus* are more or less firmly attached to the inside of the mains. Although these animalcules are not themselves pathogenic, they may harbour pathogenic organisms or virus in their intestines, thus protecting these pathogens from destruction by chlorine.

4.3.4 Chlorination, at the dosages normally employed in waterworks, is ineffective against certain parasites, including amoebic cysts; they can be excluded only by effective filtration or by higher chlorine doses than can be tolerated without subsequent dechlorination. *Amoebiasis* can be conveyed by water completely free from enteric bacteria; microscopic examination after concentration is, therefore, the only safe method of identification.

4.3.5 Strict precautions against back-syphonage and cross-connections are required, if amoebic cysts are found in a distribution system containing tested water.

4.3.6 The *cercariae of schistosomiasis* can be detected by similar microscopic examination, but there is, in

any case, no evidence to suggest that this disease is normally spread through piped water supplies.

4.3.7 The cyclops vector of the embryos of *Dracunculus medinensis* which causes dracontiasis or Guinea-worm disease can be found in open wells in a number of tropical areas. They are identifiable by microscopic examination. Such well supplies are frequently used untreated, but the parasite can be relatively easily excluded by simple physical improvements in the form of curbs, drainage, and apron surrounds and other measures which prevent physical contact with the water source.

4.3.8 Cryptosporidium shall be absent in 10 liter of water when tested in accordance with USEPA method 1622 or USEPA method 1623* or ISO 15553 : 2006.

4.3.9 Giardia shall be absent in 10 liter of water when tested in accordance with USEPA method 1623* or ISO 15553 : 2006.

4.3.10 The drinking water shall be free from microscopic organisms such as algae, zooplanktons, flagellates, parasites and toxin producing organisms. An illustrative (and not exhaustive) list is given in Annex C for guidance.

NOTE — In case of dispute, the method indicated by '*' in **4.3.8** and **4.3.9** shall be referee method.

5 SAMPLING

Representative samples of water shall be drawn as prescribed in IS 1622 and IS 3025 (Part 1).

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
1622 : 1981	Methods of sampling and microbiological examination of water (*first revision*)
3025	Methods of sampling and test (physical and chemical) for water and waste water:
(Part 1) : 1987	Sampling (*first revision*)
(Part 2) : 2002	Determination of 33 elements by inductively coupled plasma atomic emission spectroscopy
(Part 4) : 1983	Colour (*first revision*)
(Part 5) : 1983	Odour (*first revision*)
(Part 7) : 1984	Taste threshold (*first revision*)
(Part 8) : 1984	Tasting rate (*first revision*)
(Part 10) : 1984	Turbidity (*first revision*)
(Part 11) : 1983	*p*H value (*first revision*)
(Part 16) : 1984	Filterable residue (total dissolved solids) (*first revision*)
(Part 21) : 1983	Total hardness (*first revision*)
(Part 23) : 1983	Alkalinity (*first revision*)
(Part 24) : 1986	Sulphates (*first revision*)
(Part 26) : 1986	Chlorine residual (*first revision*)
(Part 27) : 1986	Cyanide (*first revision*)
(Part 29) : 1986	Sulphide (*first revision*)
(Part 32) : 1988	Chloride (*first revision*)
(Part 34) : 1988	Nitrogen (*first revision*)
(Part 37) : 1988	Arsenic (*first revision*)
(Part 39) : 1989	Oil and grease
(Part 40) : 1991	Calcium
(Part 41) : 1992	Cadmium (*first revision*)
(Part 42) : 1992	Copper (*first revision*)
(Part 43) : 1992	Phenols (*first revision*)
(Part 46) : 1994	Magnesium
(Part 47) : 1994	Lead
(Part 48) : 1994	Mercury
(Part 49) : 1994	Zinc
(Part 52) : 2003	Chromium
(Part 53) : 2003	Iron
(Part 54) : 2003	Nickel
(Part 55) : 2003	Aluminium
(Part 56) : 2003	Selenium
(Part 57) : 2005	Boron
(Part 59) : 2006	Manganese
(Part 60) : 2008	Fluoride
13428 : 2003	Packaged natural mineral water — Specification (*first revision*)
14194	Radionuclides in environmental samples — Method of estimation:
(Part 1) : 1994	Gross beta activity measurement
(Part 2) : 1994	Gross alpha activity measurement
15302 : 2002	Determination of aluminium and barium in water by direct nitrous oxide-acetylene flame atomic absorption spectrometry
15303 : 2002	Determination of antimony, iron and selenium in water by electrothermal atomic absorption spectrometry

ANNEX B

(*Clause* 4.2.7)

POLYMERASE CHAIN REACTION (PCR) METHOD

B-1 GENERAL

The method involves the concentration of viruses from 100 litre of drinking water to 1 ml by membrane filter technique. The concentrate is subjected to amplification using polymerase chain reaction (PCR) and primers based on highly conserved regions of viral genomes. This method can detect as low as 10 genome copies. Stringent precautions are needed to avoid contamination with amplified DNA products leading to false positive reactions. Detection of hepatitis A virus (HAV) RNA and enterovirus (EV) RNA is considered as an indication of presence of viruses in water. Steps involved include concentration of water, RNA extraction, complementary DNA (cDNA) synthesis and PCR.

B-2 CONCENTRATION OF DRINKING WATER

B-2.1 Apparatus

B-2.1.1 *Pressure Pump*

B-2.1.2 *Membrane Filter Assembly with 144 mm Diameter with Tripod Stand*

B-2.1.3 *Pressure Vessel (50 litre capacity) with Pressure Gauge*

B-2.1.4 *Inter-connecting Pressure Tubes*

B-2.2 Reagents

Autoclaved double distilled water shall be used for the preparation of reagents/buffers in this study.

B-2.2.1 *Aluminium Chloride*

B-2.2.2 *HCl/NaOH Urea (Extra Pure)*

B-2.2.3 *Disodium Hydrogen Phosphate* ($Na_2HPO_4.2H_2O$) — 0.2 M, filter sterilized.

B-2.2.4 *Sodium Dihydrogen Phosphate* ($NaH_2PO_4.2H_2O$) — 0.2 M, filter sterilized.

B-2.2.5 *Citric Acid* — 0.1 M, filter sterilized.

B-2.2.6 *L-Arginine* — 0.5 M, filter sterilized.

B-2.2.7 *Urea-Arginine Phosphate Buffer* (*U-APB*) — Mix 4.5 g of urea with 2 ml of 0.2 M NaH_2PO_4 and 2 ml of 0.5 M L - Arginine and make up the volume to 50 ml with sterile distilled water. The *p*H of the eluent shall be 9.0.

B-2.2.8 *Magnesium Chloride* ($MgCl_2$) — 1 M.

B-2.2.9 *McII Vaines Buffer* (*p*H *5.0*) — Mix 9.7 ml of 0.1 M citric acid with 10.3 ml of 0.2 M $Na_2HPO_4.2H_2O$ under sterile conditions.

B-2.3 Procedure

Filter 100 litre of drinking water sample through membrane filter assembly using either positively charged membrane of 144 mm diameter or 0.22 micron diameter pore size nitrocellulose membrane. For positively charged membrane the test water *p*H need not be adjusted. But for the 0.22 micron nitrocellulose membrane adjust the *p*H to 3.5 after adding the aluminium chloride as a coagulant to a final concentration of 0.000 5 M.

At lower *p*H pass the water through the membrane. The flow rate shall be 40 litre/h approximately. After the completion of the filtration, elute the adsorbed particles using 100 ml of urea-arginine phosphate buffer (U-APB). Precipitate the suspended particles using 1 ml of magnesium chloride (1 M). Dissolve the resultant precipitate centrifuged out of the sample in 800-1.0 ml of McII vaines buffer. The processed sample can be stored at refrigerator until required.

B-3 RNA EXTRACTION

B-3.1 Apparatus

B-3.1.1 *Cooling Centrifuge*

B-3.1.2 *Deep Freezer (–20°C)*

B-3.1.3 *Vortex Mixer*

B-3.1.4 *Pipette Man*

B-3.2 Reagents

B-3.2.1 *Cetyl Trimethyl Ammonium Bromide (CTAB) Buffer*

CTAB	:	1 percent
Sodium Dodecyl Sulphate (SDS)	:	1 percent
EDTA	:	20 mM
Sodium Chloride	:	1 M

B-3.2.2 *Phenol, Chloroform and Isoamylalcohol in the ratio of 25:24:1 (PCI)*

B-3.2.3 *Ethanol*

B-3.2.4 *TE Buffer (p*H *8.0)*

Tris base	:	1 M
EDTA	:	0.5 M

B-3.2.5 *Sodium Acetate* — 3 M.

B-3.3 Procedure

Treat 300 µl of concentrated water sample with equal volume of CTAB and 1/10th volume of PCI. Vortex and centrifuge at 5 000 × g for 30 min at 4°C. Add 1/10th volume of 3 M sodium acetate and double the volume of cold ethanol to the aqueous layer. Keep the mixture at either at –20°C for overnight or in liquid nitrogen for 2-5 min. Centrifuge at 10 000 × g, for 30 min at 4°C. Discard the supernatant and air dry the pellet and dissolve it in 20 µl TE buffer.

B-4 COMPLEMENTARY DNA (c DNA) SYNTHESIS

B-4.1 Apparatus

B-4.1.1 *PCR Machine*

B-4.1.2 *Deep Freezer (–20°C)*

B-4.2 Reagents

B-4.2.1 *cDNA Synthesis Kit*

B-4.3 Procedure

Suspend the extracted RNA in 20 µl of cDNA reaction mixture, which consists of 4 µl of 5X reverse transcriptase reaction buffer [250 mM TRIS–HCl (*p*H 8.5), 40 mM KCl, 150 mM $MgCl_2$, 5 mM dithiothreitol (DTT)], 0.5 µl of 10 mM deoxynucleotide phosphate (dNTP), 2 µl of hexa nucleotide mixture, 1 µl of 25 U of Maloney Murine Leukaemia Virus (M-MuLV) reverse transcriptase, 0.5 µl of 20 U of human placental RNase inhibitor. Heat the reaction mixture to 95°C for 5 min and rapidly chill on ice, this is followed by the addition of 1 µl (25 U/µl) of M-MuLV reverse transcriptase. Incubate the reaction mixture as given by the manufacturer of the kit and quickly chill the reaction tube on ice.

B-5 PCR AMPLIFICATION

B-5.1 Apparatus

B-5.1.1 *PCR Machine*

B-5.1.2 *Deep Freezer (–20°C)*

B-5.1.3 *Micropippette*

B-5.2 Reagents

B-5.2.1 *Primers for EV and HAV*

EV sense primer, 5' — TCC TCC GGC CCC TGA ATG CG — 3'

antisense primer, 5' — ATT GTC ACC ATA AGC AGC CA — 3'

HAV sense primer, 5' — GTTTT GCTCC TCTTT ATCAT GCTAT G-3'

antisense primer, 5' — GGAAA TGTCT CAGGT ACTTT CTTTG-3'

B-5.2.2 *PCR Master Mix*

B-5.2.3 *Mineral Oil*

B-5.3 Procedure

B-5.3.1 *PCR Amplification for Hepatitis A Virus (HAV)*

In 5 µl of cDNA, add 95 µl of a PCR Master Mix (10 mM TRIS–HCl (*p*H 8.3), 50 mM KCl, 2.5 mM $MgCl_2$, 0.01 percent gelatin (1× PCR buffer), 200 µM of each dNTP, 1.5 U of *Thermus aquaticus* polymerase). Add 25 pico moles of sense and antisense oligonucleotide primers of HAV and overlay with mineral oil. Appropriate positive and negative controls shall be included with each run. Set the following reaction at thermo cycler:

Denaturation at 94°C for 2 min

Denaturation for	1.0 min	at 94°C	35 cycles
Annealing for	1.0 min	at 57°C	
Extension for	1.3 min	at 72°C	

Final extension at 72°C for 7 min.

B-5.3.2 *PCR Amplification for Enterovirus (EV)*

In 5 µl of cDNA, add 95 µl of a PCR Master Mix (10 mM TRIS–HCl (*p*H 8.3), 50 mM KCl, 2.5 mM $MgCl_2$, 0.01 percent gelatin (1X PCR buffer), 200 µM of each dNTP, 1.5 U of *Thermus aquaticus* polymerase). Add 25 pico moles of sense and antisense oligonucleotide primers of EV and overlay with mineral oil. Appropriate positive and negative controls shall be included with each run. Set the following reaction at thermo cycler:

Denaturation at 94°C for 2 min

Denaturation for	1.0 min	at 94°C	35 cycles
Annealing for	1.0 min	at 42°C	
Extension for	2.0 min	at 72°C	

Final extension at 72°C for 7 min.

B-6 AGAROSE GEL ELECTROPHORESIS

B-6.1 Apparatus

B-6.1.1 *Micropippette*

B-6.1.2 *Electrophoresis Apparatus*

B-6.1.3 *Gel Documentation System*

B-6.2 Reagents

B-6.2.1 *Running Buffer* — 50X TAE buffer

Tris base/Tris buffer : 121.00 g

Glacial acetic acid	:	28.55 ml
0.5 M EDTA	:	50 .00 ml
Distilled water (autoclaved)	:	300.45 ml

Make the final volume upto 1 000 ml with deionised distilled water, sterilize and store at 4°C. The final concentration for the preparation of agarose gel and to run the gel shall be 1X.

B-6.2.2 *Tracking Dye* — 6X bromophenol blue.

B-6.2.3 *Ethidium Bromide* — 0.5 µg/ml.

B-6.3 Procedure

Run the PCR amplified product of EV and HAV on 1.5 percent agarose gel using 1X TAE buffer. Load 10 µl of amplified product after mixing it with 1 µl 10X loading dye. Run the molecular weight marker along with the samples. Run the electrophoresis at 100 V for 30 min. Stain the gel with ethidium bromide (0.5 µl/ml) for 20 min. Wash it with distilled water and view under UV transilluminator and photograph the gel to analyse the band pattern. EV gives the band as 155 base pair and the HAV gives band as 225 base pair.

ANNEX C

(*Clause* 4.3.10)

ILLUSTRATIVE LIST OF MICROSCOPIC ORGANISMS PRESENT IN WATER

Sl No. (1)	*Classification of Microscopic Organism* (2)	*Group and Name of the Organism* (3)	*Habitat* (4)	*Effect of the Organisms and Significance* (5)
i)	Algae	a) Chlorophyceae:		
		1) *Species of* Coelastrum, Gomphospherium, Micractinium, Mougeotia, Oocystis, Euastrum, Scenedesmus, Actinastrum, Gonium, Eudorina Pandorina, Pediastrum, Zygnema, Chlamydomonas, Careteria, Chlorella, Chroococcus, Spirogyra, Tetraedron, Chlorogonium, Stigeoclonium	Polluted water, impounded sources	Impart colouration
		2) *Species of* Pandorina, Volvox, Gomphospherium, Staurastrum, Hydrodictyon, Nitella	Polluted waters	Produce taste and odour
		3) *Species of* Rhizoclonium, Cladothrix, Ankistrodesmus, Ulothrix, Micrasterias, Chromulina	Clean water	Indicate clean condition
		4) *Species of* Chlorella, Tribonema, Clostrium, Spirogyra, Palmella	Polluted waters, impounded sources	Clog filters and create impounded difficulties
		b) Cyanophyceae:		
		1) *Species of* Anacystis and Cylindrospermum	Polluted waters	Cause water bloom and impart colour
		2) *Species of* Anabena, Phormidium, Lyngbya, Arthrospira, Oscillatona	Polluted waters	Impart colour
		3) *Species of* Anabena, Anacystis, Aphanizomenon	Polluted waters, impounded sources	Produce taste and odour
		4) *Species of* Anacystis, Anabena, Coelospherium, Cleotrichina, Aphanizomenon	Polluted waters	Toxin producing
		5) *Species of* Anacystis, Rivularia, Oscillatoria, Anabena	Polluted waters	Clog filters

Sl No. (1)	*Classification of Microscopic Organism* (2)	*Group and Name of the Organism* (3)	*Habitat* (4)	*Effect of the Organisms and Significance* (5)
		6) *Species of* Rivularia	Calcareous waters and also rocks	Bores rocks and calcareous strata and causes matted growth
		7) *Species of* Agmenellum, Microcoleus, Lemanea	Clean waters	Indicators of purification
		c) Diatoms (Bacillareophyceae):		
		1) *Species of* Fragillaria, Stephanodiscus, Stauroneis	—	Cause discoloration
		2) *Species of* Asterionella, Tabellaria	Hill streams high altitude, torrential and temperate waters	Taste and odour producing clog filters
		3) *Species of* Synedra and Fragillavia	Polluted waters	Taste and odour producing
		4) *Species of* Nitzchia, Gomphonema	Moderately polluted waters	Cause discoloration
		5) *Species of* Cymbela, Synedra, Melosira, Navicula, Cyclotella, Fragillaria, Diatoma, Pleurogsigma	Rivers and streams impounded sources	Clog filters and cause operational difficulties
		6) *Species of* Pinmularia, Surinella, Cyclotella, Meridion, Cocconeis	Clean waters	Indicators of purification
		d) Xanthophyceae:		
		Species of Botryococcus	Hill streams, high altitude and temperate waters	Produces coloration
ii)	Zooplankton	a) Protozoa:		
		1) Amoeba, Giardia Lamblia Arcella, Difflugia, Actinophrys	Polluted waters	Pollution indicators
		2) Endamoeba, Histolytica	Sewage and activated sludge	Parasitic and pathogenic
		b) Ciliates:		
		Paramoecium, Vorticella, Carchesium, Stentor, Colpidium, Coleps, Euplotes, Colopoda, Bodo	Highly polluted waters, sewage and activated sludge	Bacteria eaters
		c) Crustacea:		
		1) Bosmina, Daphnia	Stagnant polluted waters	Indicators of pollution
		2) Cyclops	Step wells in tropical climate	Carrier host of guinea worm
iii)	Rotifers	a) Rotifers:		
		Anurea, Rotaria, Philodina	Polluted and Algae laden waters	Feed on algae
		b) Flagellates:		
		1) Ceratium, Glenodinium, Peridinium Dinobryon	Rocky strata, iron bearing and acidic waters	Impart colour and fishy taste
		2) Euglena, Phacus	Polluted waters	Impart colour

Sl No.	*Classification of Microscopic Organism*	*Group and Name of the Organism*	*Habitat*	*Effect of the Organisms and Significance*
(1)	(2)	(3)	(4)	(5)
iv)	Miscellaneous Organisms	a) Sponges, Hydra	Fresh water	Clog filters and affect purification systems
		b) Tubifex, Eristalls, Chironomids	Highly polluted waters, sewage and activated sludge and bottom deposits	Clog filters and render water unaesthetic
		c) Plumatella	Polluted waters	Produces biological slimes and causes filter operational difficulties
		c) Dreissena, Asellus	Polluted waters	Harbour pathogenic organisms

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Annexure –IV

Primary Water Quality Criteria for Bathing under Environment Protection Amendment Rules, 1986	
Faecal Coliform:	500 MPN/100mL (desirable) 2500 MPN/100mL (Maximum Permissible)
Faecal Streptococci:	100 MPN/100mL (desirable) 500 MPN/100mL (Maximum Permissible)
pH:	Between 6.5-8.5
Dissolved Oxygen:	5 mg/L or more
Biochemical Oxygen Demand: **(3 day, 27°C)**	3 mg/L or less