Manual on Water Supply and Treatment, 1999

(Excerpts - water quality standards sections)

MANUAL ON WATER SUPPLY AND TREATMENT

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2.2.9 QUALITY STANDARDS

The objective of Water Works Management is to ensure that the water supplied is free from pathogenic organisms, clear, palatable and free from undesirable taste and odour, of reasonable temperature, neither corrosive nor scale forming and free from minerals which could produce undesirable physiological effects. The establishment of minimum standards of quality for public water supply is of fundamental importance in achieving this objective. Standards of quality form the yardstick within which the quality control of any public water supply has to be assessed.

Sanitary inspections are intended to provide a range of information and to locate potential problems. The inspections allow for an overall appraisal of many factors associated with a water supply system, including the water works and the distribution system. Moreover such an appraisal may later be verified and confirmed by microbiological analysis, which will indicate the severity of the problem. Sanitary inspections thus provide a direct method of pinpointing possible problems and sources of contamination. They are also important in the prevention and control of potentially hazardous conditions, including epidemics of water borne diseases. The data obtained may identify failures, anomalies, operator errors and any deviations from normal that may affect the production and

distribution of safe drinking water. When the inspections are properly carried out at appropriate regular intervals and where the inspector has the knowledge necessary to detect problems and suggest technical solutions, the production of good quality water is ensured.

The evolution of standards for the quality control of public water supplies has to take into account the limitations imposed by local factors in the several regions of the country. The Environmental Hygiene Committee (1949) recommended that the objective of a public water supply should be to supply water "that is absolutely free from risks of transmitting diseases, is pleasing to the senses and is suitable for culinary and laundering purposes" and added that "freedom from risks is comparatively more important than physical appearance or hardness" and that safety is an obligatory standard and physical and chemical qualities are optional within a range. These observations are relevant in the development of a country-wide programs of protected water supply systems for communities big and small, making use of the available water resources in the different regions, with a wide variation in their physical, chemical and aesthetic qualities, that can be achieved by communities in due course within the limits of their financial resources. The immediate need is for minimum standards, consistent with the safety of public water supplies. Considering the standards prescribed in the earlier Manual and further development in the international standardization and the conditions in the country, the following guidelines are recommended.

a) Physical And Chemical Quality Of Drinking Water

The physical and chemical quality of drinking water should be in accordance with the recommended guidelines presented in Table 2.2.

TABLE 2.2

RECOMMENDED GUIDELINES FOR PHYSICAL AND CHEMICAL PARAMETERS

Sl. No.	Characteristics	*Acceptable	**Cause for Rejection
1.	Turbidity (NTU)	1	10
2.	Colour (Units on Platinum Cobalt scale)	5	25
3.	Taste and Odour	Unobjectionable	Objectionable
4.	pH	7. 0 to 8.5	<6.5 or > 9.2
5.	Total dissolved solids (mg/l)	500	2000
6.	Total hardness (as $CaCO_3$) (mg/l)	200	600
7.	Chlorides (as Cl) (mg/l)	200	1000
8.	Sulphates (as SO_4) (mg/l)	200	400
9.	Fluorides (as F) (mg/l)	1.0	1.5
10.	Nitrates (as NO_3) (mg/l)	45	45
11.	Calcium (as Ca) (mg/l)	75	200
12.	Magnesium (as Mg) (mg/l)	≤ 30	150

Sl. No.	Characteristics	*Acceptable	**Cause for Rejection
If there are 250 mg/l of sulphates, Mg 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
14.	Manganese (as Mn) (mg/l)	0.05	0.5
15.	Copper (as Cu) (mg/l)	0.05	1.5
16.	Aluminium (as Al) (mg/l)	0.03	0.2
17.	Alkalinity (mg/l)	200	600
18.	Residual Chlorine (mg/l)	0.2	>1.0
19.	Zinc (as Zn) (mg/l)	5.0	15.0
20.	Phenolic compounds (as Phenol) (mg/l)	0.001	0.002
21.	Anionic detergents (mg/l) (as MBAS)	0.2	1.0
22.	Mineral Oil (mg/l)	0.01	0.03
	TOXIC MATERIALS		
23.	Arsenic (as As) (mg/l)	0.01	0.05
24.	Cadmium (as Cd) (mg/l)	0.01	0.01
25.	Chromium (as hexavalent Cr) (mg/l)	0.05	0.05
26.	Cyanides (as CN) (mg/l)	0.05	0.05
27.	Lead (as Pb) (mg/l)	0.05	0.05
28.	Selenium (as Se) (mg/l)	0.01	0.01
29.	Mercury (total as Hg) (mg/l)	0.001	0.001
30.	Polynuclear aromatic hydrocarbons (PAH) (µg/l)	0. 2	0. 2
31.	Pesticides (total, mg/l)	Absent	Refer to WHO guidelines for drinking water quality Vol I. – 1993
	RADIO ACTIVITY+		
32.	Gross Alpha activity (Bq/l)	0.1	0.1
33.	Gross Beta activity (Bq/l)	1.0	1.0

NOTES

* The figures indicated under the column 'Acceptable' are the limits upto which water is generally acceptable to the consumers.

** Figures in excess of those mentioned under 'Acceptable' render the water not

acceptable, but still may be tolerated in the absence of an alternative and better source but upto the limits indicated under column "Cause for Rejection" above which the sources will have to be rejected.

\+ It is possible that some mine and spring waters may exceed these radio activity limits and in such cases it is necessary to analyze the individual radio-nuclides in order to assess the acceptability or otherwise for public consumption.

b) Bacteriological Guidelines

The recommended guidelines for bacteriological quality are given in Table 2.3.

TABLE 2.3
BACTERIOLOGICAL QUALITY OF DRINKING WATER[a]

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

Source : WHO guidelines for Drinking Water Quality Vol.1 – 1993.

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

[b] 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 test must be carried out. Total coliform bacteria are not acceptable indicators of the sanitary quality of rural water supplies, particularly in tropical areas where many bacteria of no sanitary significance occur in almost all untreated supplies.

[c] 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, as recommended in volume 3 of W.H.O. *guidelines for drinking-water quality1993.*

c) Virological Quality

Drinking water must essentially be free of human enteroviruses to ensure negligible risk of transmitting viral infection. Any drinking-water supply subject to faecal contamination presents a risk of a viral disease to consumers. Two approaches can be used to ensure that the risk of viral infection is kept to a minimum: providing drinking water from a source verified free of faecal contamination, or adequately treating faecally contaminated water to reduce enteroviruses to a negligible level.

Virological studies have shown that drinking water treatment can considerably reduce the levels of viruses but may not eliminate them completely from very large volumes of water. Virological, epidemiological, and risk analysis are providing important information, although it is still insufficient for deriving quantitative and direct virological criteria. Such criteria can not be recommended for routine use because of the cost, complexity, and lengthy nature of virological analysis, and the fact that they can-not detect the most relevant viruses.

The guideline criteria shown in Table 2.4 are based upon the likely viral content of source waters and the degree of treatment necessary to ensure that even very large volumes of drinking water have negligible risk of containing viruses.

Ground water obtained from a protected source and documented to be free from faecal contamination from its zone of influence, the well, pumps, and delivery system can be assumed to be virus-free. However, when such water is distributed, it is desirable that it is disinfected, and that a residual level of disinfectant is maintained in the distribution system to guard against contamination.

TABLE 2.4

RECOMMENDED TREATMENT FOR DIFFERENT WATER SOURCES TO PRODUCE WATER WITH NEGLIGIBLE VIRUS RISK[a]

Type of Source	Recommended Treatment
Ground water	
Protected, deep wells; essentially free of faecal contamination	Disinfection[b]
Unprotected, shallow wells; faecally contaminated	Filtration and disinfection
Surface water	
Protected, impounded upland water; essentially free of faecal contamination	Disinfection
Unprotected impounded water or upland river; faecal contamination	Filtration and disinfection

Type of Source	Recommended Treatment
Unprotected lowland rivers; faecal contamination	Pre-disinfection or storage, filtration, disinfection
Unprotected watershed; heavy faecal contamination	Pre-disinfection or storage, filtration, additional treatment and disinfection
Unprotected watershed; gross faecal contamination	Not recommended for drinking water supply

[a] For all sources, the median value of turbidity before terminal disinfection must not exceed 1 nephelometric turbidity unit(NTU) and must not exceed 5 NTU in single sample.

Terminal disinfection must produce a residual concentration of free chlorine of ≥0.5 mg/litre after atleast 30 minutes of contact in water at pH < 8.0, or must be shown to be an equivalent disinfection process in terms of the degree of enterovirus inactivation(>99.99%).

Filtration must be *either slow sand filtration or rapid filtration* (sand, dual, or mixed media) preceded by adequate coagulation-flocculation (with sedimentation or floatation). Diatomaceous earth filtration or filtration process demonstrated to be equivalent for virus reduction can also be used. The degree of virus reduction must be >90%.

Additional treatment may consist of slow sand filtration, ozonation with granular activated carbon adsorption, or any other process demonstrated to achieve > 99% enterovirus reduction.

[b] Disinfection should be used if monitoring has shown the presence of *E. coli* or thermo-tolerant coliform bacteria.

SOURCE : W.H.O. guidelines for Drinking Water Quality – 1993.