

Energy and Environment Engineering

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Energy and Environmental Engineering

CEME106

ENVIRONMENT AND ECOSYSTEMS

Introduction: Concept of an ecosystem- structure and functions of ecosystem. Components of ecosystem - producers, consumers, decomposers, Food chains, food webs, ecological pyramids, Energy flow in ecosystem. Bio-geo- chemical cycles, Hydrologic cycle
Components of Environment and their relationship, Impact of technology on environment, Environmental degradation. Environmental planning of urban network services such as water supply, sewerage, solid waste management.

ENVIRONMENTAL POLLUTION

Water, air, soil, noise, thermal and radioactive, marine pollution: sources, effects and engineering control strategies. Drinking water quality and standards, Ambient air and noise quality standards

GLOBAL ENVIRONMENTAL ISSUES AND ITS MANAGEMENT

Engineering aspects of climate change. Acid rain, depletion of ozone layer. Concept of carbon credit. Concepts of Environmental impact assessment and Environmental audit. Environmental life cycle assessment

Water

Sources of Water

1. **Ground Water**
2. **Surface Water**
3. **Harvested Water**

- **Precipitation:** Fog, Mist, Rain, Snow, Sleet
- **Runoff:** Brook, Creek, Stream, River
- **Water Table:** Puddle, Pond, Lake (Ocean not freshwater)
- **Aquifers:** Porous rock, wells, artesian wells, springs

Facts

- **Two thirds** of our planet is covered by water.
- **97.5%** of the water is saltwater.
- The majority of freshwater is beyond our reach, locked into polar snow and ice.

- **66%** of the human body is made up of water.
- At just **2%** dehydration your performance decreases by around **20%**.
- We should drink at least **1½ litres** of water a day.

Facts

- The number of people with access to clean water has **doubled** in the last 20 years.
- **1.1 billion** people in the world still do not have access to safe water. This is nearly **20%** of the population.

An average bath uses **80 litres** of water.

An average shower only uses **35 litres**.

Minimum 65 litres of water required for basic need

Facts

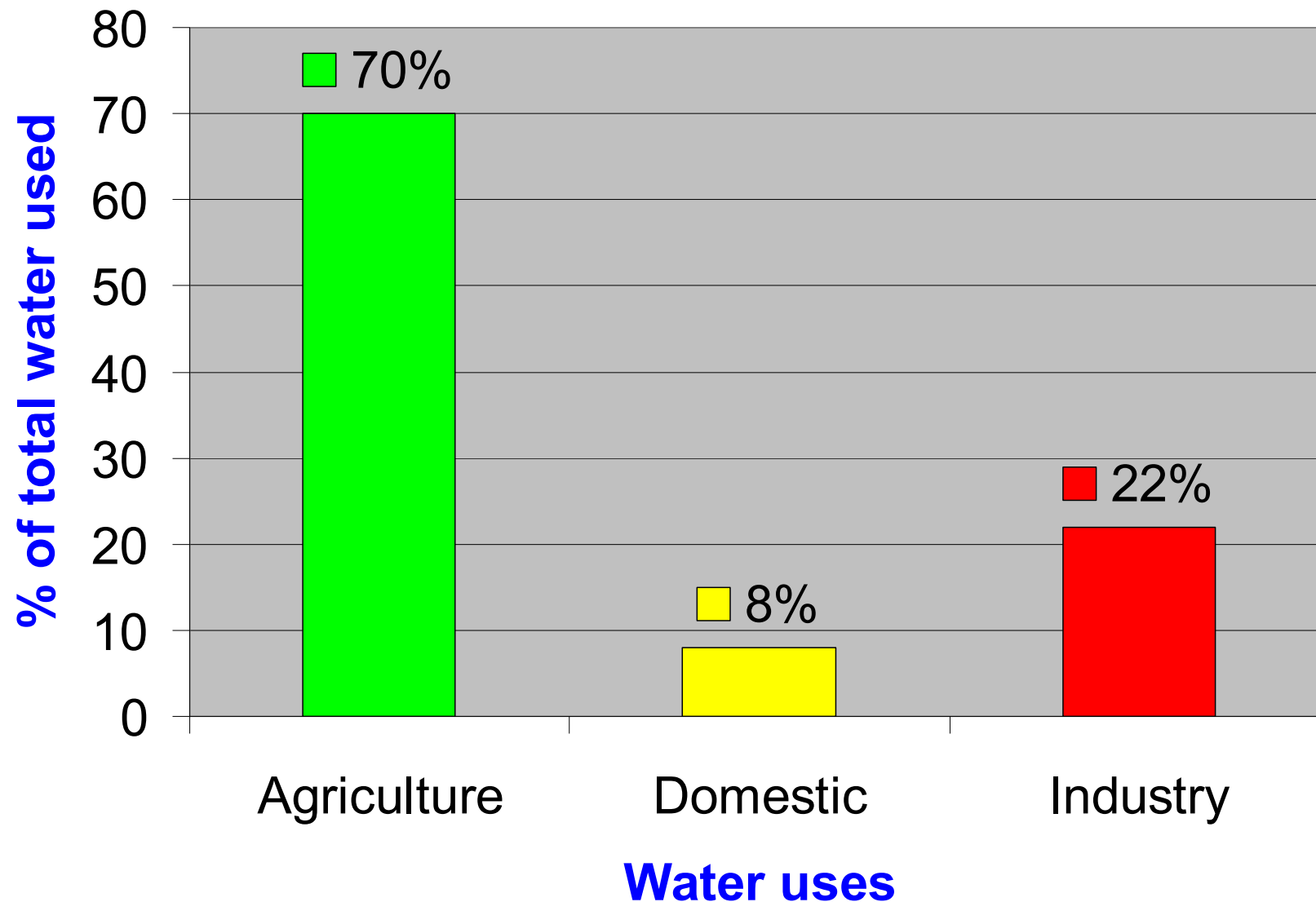
Diseases

- **80%** of all illness in developing countries is caused by water related diseases.
- **90%** of wastewater in developing countries is discharged directly into rivers and streams without treatment.

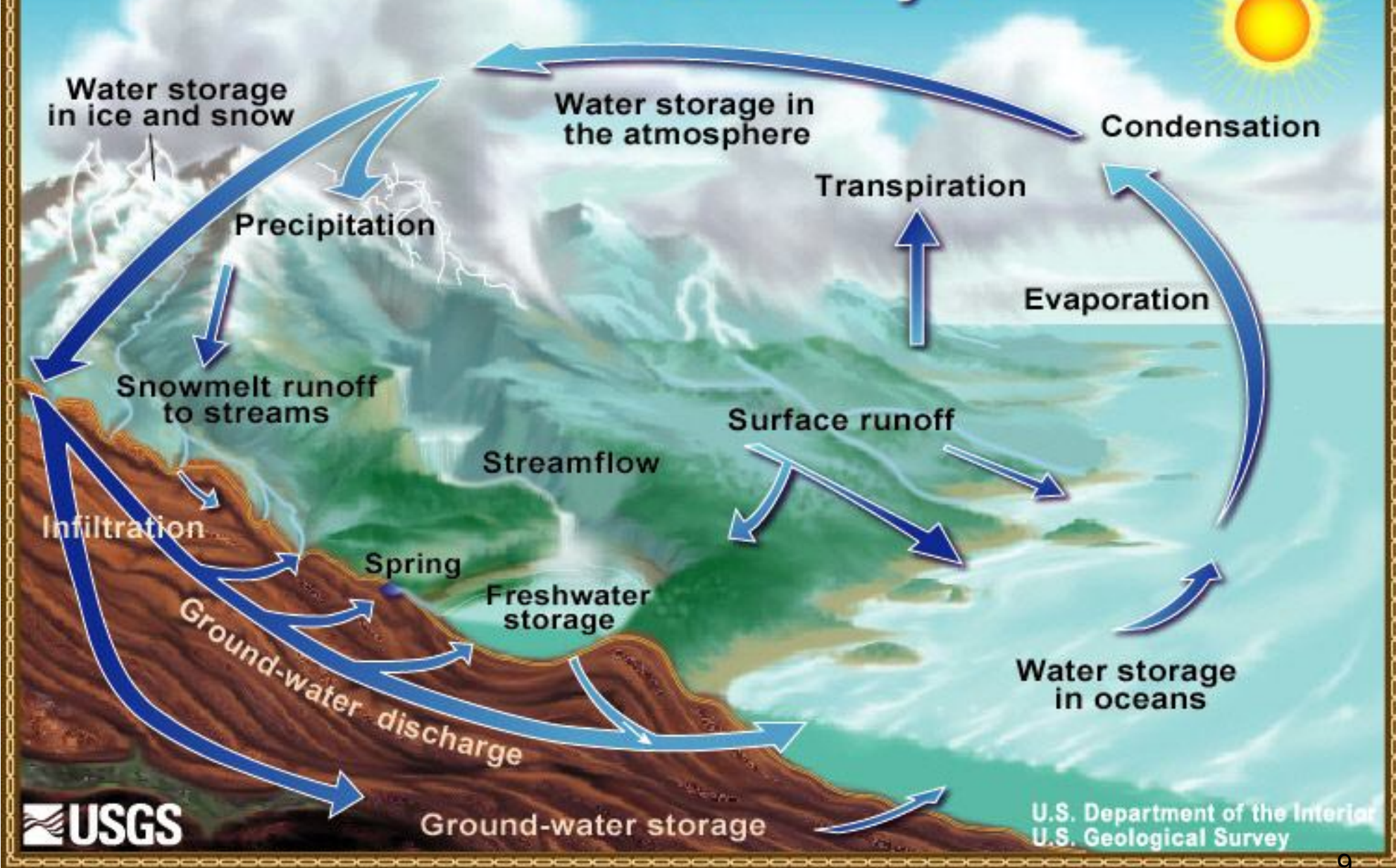
Water Future

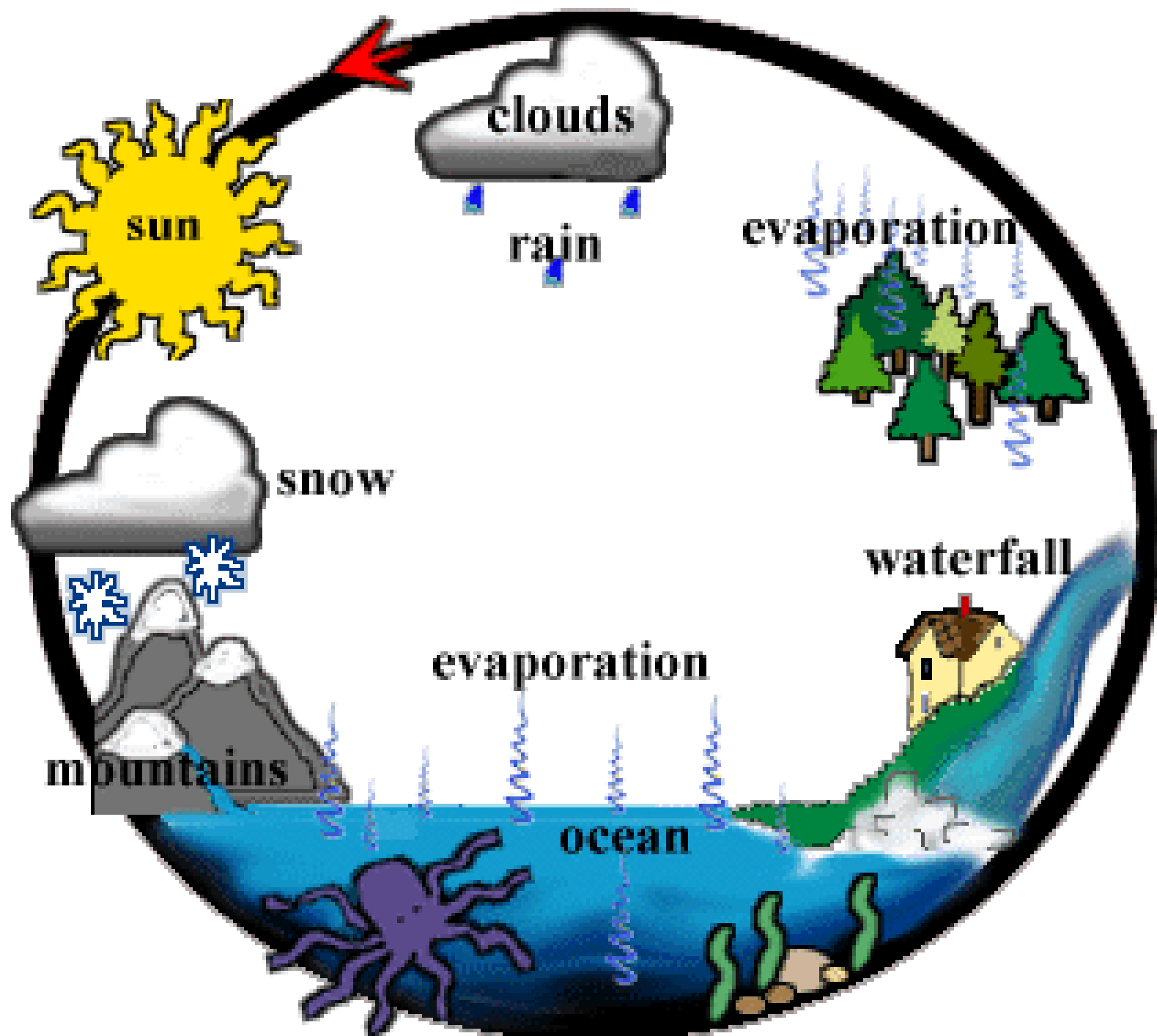
- The UN estimates that by 2025, 75% of the world population won't have reliable, clean water.

Uses of Water in Different Area



The Water Cycle





Water never leaves the Earth. It is constantly being cycled through the atmosphere, ocean, and land. This process, known as the **water cycle**, is driven by energy from the sun. The water cycle is crucial to the existence of life on our planet.

During part of the water cycle, the sun heats up liquid water and changes it to a gas by the process of **evaporation**. Water that evaporates from Earth's oceans, lakes, rivers, and moist soil rises up into the atmosphere.

The process of evaporation from plants is called **transpiration**. (In other words, it's like plants sweating.)

When the water in the clouds gets too heavy, the water falls back to the earth. This is called **precipitation**. Ground water is major source of precipitation

As water (in the form of gas) rises higher in the atmosphere, it starts to cool and become a liquid again. This process is called **condensation**. When a large amount of water vapor condenses, it results in the formation of clouds.

When rain falls on the land, some of the water is absorbed into the ground forming pockets of water called groundwater. Most groundwater eventually returns to the ocean. Other precipitation runs directly into streams or rivers. Water that collects in rivers, streams, and oceans is called **runoff**.

Water Pollution

Water pollution can be defined as presence of solid, liquid or gaseous contaminants in such concentration that may alter the quality of water and harmful to the living organism.

Types of Pollution:

- 1.Surface water
- 2.Ground water

Sources of Pollution

- 1.Point
- 2.Non-point

Causes of Water Pollution

The principal sources of water pollution are..

1. Domestic waste
2. Sewage System
3. Solid Waste
4. Industrial Waste
5. Acid Rain
6. Oil Industry
7. Religious means
8. Aquatic Plants

Effect of water Pollution

- ❖ Deterioration in quality of water
- ❖ Disruption of food-chains
- ❖ Death of aquatic organisms
- ❖ Rivers are changed into dustbin/gutters
- ❖ Shortage of drinking water

Point source pollution

Point source pollution refers to contaminants that enter a waterway through a discrete conveyance, such as a pipe or ditch.

Examples-

- ✓ Discharges from a sewage treatment plant,
- ✓ Discharges from a factory,
- ✓ City storm drain.

Non-point source pollution

- Non-point source (NPS) pollution refers to diffuse contamination that does not originate from a single discrete source.
- NPS pollution is often accumulative effect of small amounts of contaminants gathered from a large area
- The leaching out of nitrogen compounds from agricultural land which has been fertilized is a typical example.

Treatment of Water

Treatment of water is required to remove the following impurities

- ✓ Physical
- ✓ Chemical
- ✓ Biological

Method/Technique use for water treatment

1. Settling/ Sedimentation
2. Filtration
3. Ion Exchange
4. Reverse Osmosis
5. Distillation
6. Neutralizing agent
7. Chlorination
8. Ozonation
9. Activated carbon, Air stripping

Disinfection

The main purpose of disinfection to make drinking water free of any disease causing bacteria and microorganism

When aim is to kill the all microorganism that process known as **Sterilization** but when aim is to reduce the microorganism up to safe limit that process known as **Disinfection**

Criteria of selection of Disinfectant :

- 1. Effective in killing the microorganism within the contact time**
- 2. Safe to handle simple to application**
- 3. Readily available at reasonable cost**
- 4. No change in water aesthetic, and other properties**
- 5. Ability to persist in residual concentration**

Method of Disinfection

Physical:

Heat

Light

Chemical:

Oxidizing agent

Metal Ions

Alkalis and Acids

Surface active chemicals

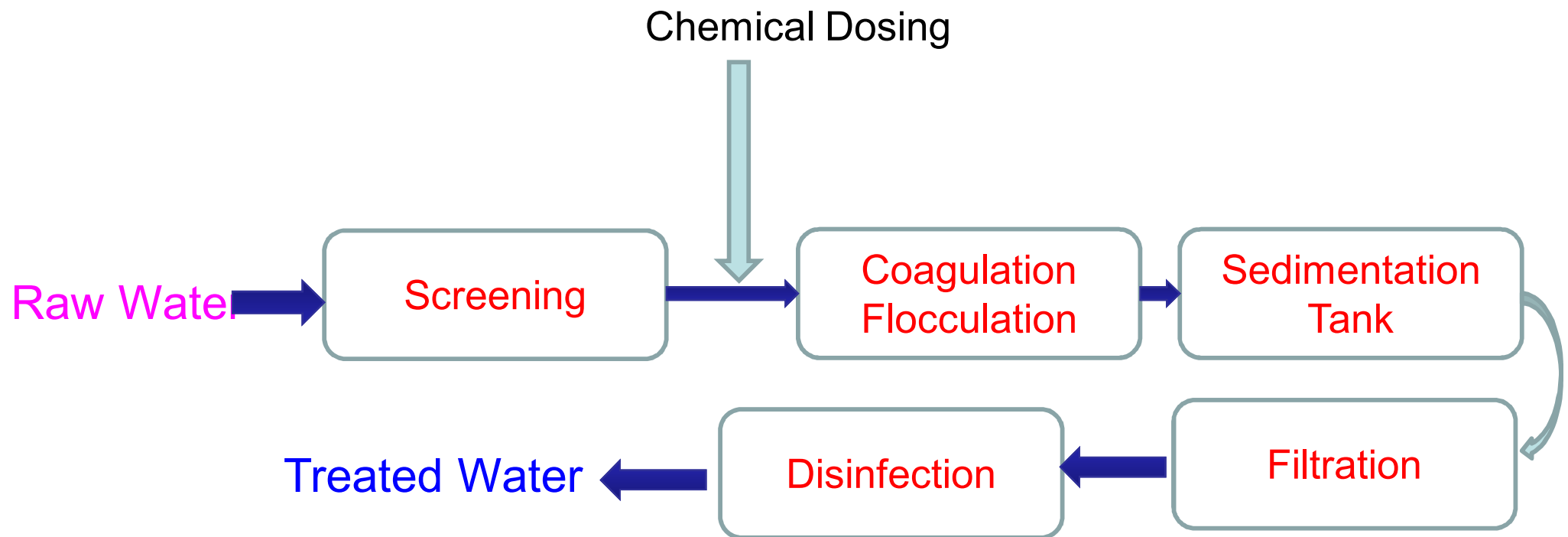
Most Common Methods of Disinfection at Household Level

1. Boiling of Water:
 - Minimum 20 min at boiling condition
2. Excess Lime Treatment:
 - 10-20 ppm as CaO
3. Silver Treatment
4. Ultraviolet Rays Treatment
5. Potassium Permanganate Treatment
 - Dose 1-2 mg/L
 - Contact time 4-6 hours
 - Water can not used for 48 hours

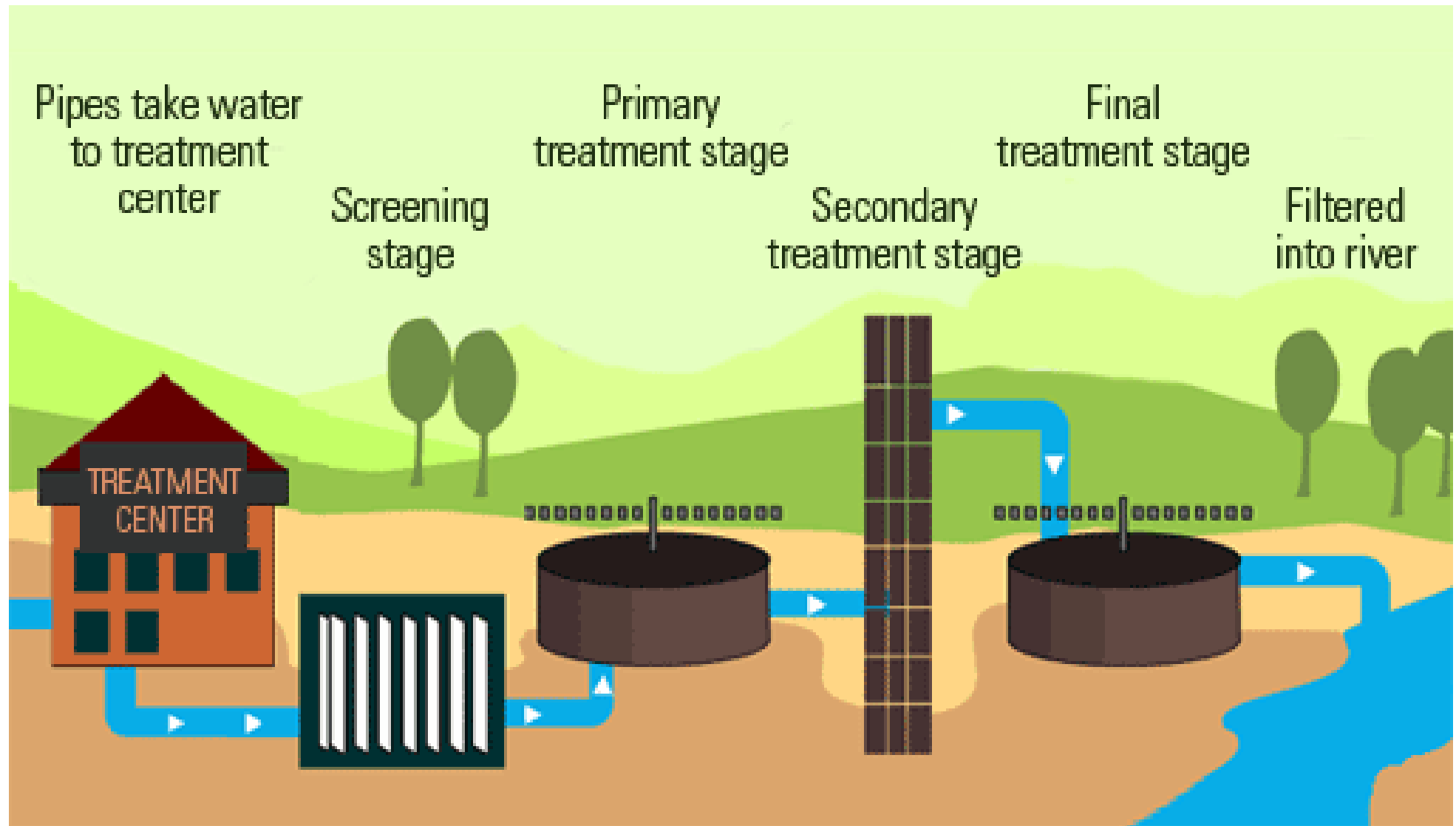
Most Common Disinfection Method at Commercial Scale

1. Chlorination
2. Ozonation
3. Ultraviolet Radiation

Water Treatment Plant Flow Diagram



Unit treatment	Function (removal)
Aeration, chemicals use	Colour, Odour, Taste
Screening	Floating matter
Chemical methods	Iron, Manganese, etc.
Softening	Hardness
Sedimentation	Suspended matter
Coagulation	Suspended matter, a part of colloidal matter and bacteria
Filtration	Remaining colloidal dissolved matter, bacteria
Disinfection	Pathogenic bacteria, Organic matter and Reducing substances



WATER QUALITY STANDARD

Indian Standard

Drinking Water - Specification

IS 10500 : 1991

Indian Standard for Drinking Water as per BIS specifications (IS 10500-2012) (Second Revision)

- BIS (Bureau of Indian Standards)
- Desirable limits
- Permissible limit

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, <i>Max</i>	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)	pH 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, <i>Max</i>	1	5	Part 10	—
vi)	Total dissolved solids, mg/l, <i>Max</i>	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, <i>Max</i>	0.03	0.2	IS 3025 (Part 55)	—
ii)	Ammonia (as total ammonia-N), mg/l, <i>Max</i>	0.5	No relaxation	IS 3025 (Part 34)	—
iii)	Anionic detergents (as MBAS) mg/l, <i>Max</i>	0.2	1.0	Annex K of IS 13428	—
iv)	Barium (as Ba), mg/l, <i>Max</i>	0.7	No relaxation	Annex F of IS 13428* or IS 15302	—
v)	Boron (as B), mg/l, <i>Max</i>	0.5	1.0	IS 3025 (Part 57)	—
vi)	Calcium (as Ca), mg/l, <i>Max</i>	75	200	IS 3025 (Part 40)	—
vii)	Chloramines (as Cl ₂), mg/l, <i>Max</i>	4.0	No relaxation	IS 3025 (Part 26)* or APHA 4500-Cl G	—
viii)	Chloride (as Cl), mg/l, <i>Max</i>	250	1 000	IS 3025 (Part 32)	—
ix)	Copper (as Cu), mg/l, <i>Max</i>	0.05	1.5	IS 3025 (Part 42)	—
x)	Fluoride (as F) mg/l, <i>Max</i>	1.0	1.5	IS 3025 (Part 60)	—
xi)	Free residual chlorine, mg/l, <i>Min</i>	0.2	1	IS 3025 (Part 26)	To be applicable only when water is chlorinated. Tested at consumer end. When pro- tection against viral infec- tion is required, it should be minimum 0.5 mg/l
xii)	Iron (as Fe), mg/l, <i>Max</i>	0.3	No relaxation	IS 3025 (Part 53)	Total concentration of man- ganese (as Mn) and iron (as Fe) shall not exceed 0.3 mg/l
xiii)	Magnesium (as Mg), mg/l, <i>Max</i>	30	100	IS 3025 (Part 46)	—
xiv)	Manganese (as Mn), mg/l, <i>Max</i>	0.1	0.3	IS 3025 (Part 59)	Total concentration of man- ganese (as Mn) and iron (as Fe) shall not exceed 0.3 mg/l

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)
xiii)	Magnesium (as Mg), mg/l, <i>Max</i>	30	100	IS 3025 (Part 46)	—
xiv)	Manganese (as Mn), mg/l, <i>Max</i>	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, <i>Max</i>	0.5	No relaxation	Clause 6 of IS 3025 (Part 39) Infrared partition method	
xvi)	Nitrate (as NO ₃), mg/l, <i>Max</i>	45	No relaxation	IS 3025 (Part 34)	—
xvii)	Phenolic compounds (as C ₆ H ₅ OH), mg/l, <i>Max</i>	0.001	0.002	IS 3025 (Part 43)	—
xviii)	Selenium (as Se), mg/l, <i>Max</i>	0.01	No relaxation	IS 3025 (Part 56) or IS 15303*	—
xix)	Silver (as Ag), mg/l, <i>Max</i>	0.1	No relaxation	Annex J of IS 13428	—
xx)	Sulphate (as SO ₄), mg/l, <i>Max</i>	200	400	IS 3025 (Part 24)	May be extended to 400 provided that Magnesium does not exceed 30
xxi)	Sulphide (as H ₂ S), mg/l, <i>Max</i>	0.05	No relaxation	IS 3025 (Part 29)	
xxii)	Total alkalinity as calcium carbonate, mg/l, <i>Max</i>	200	600	IS 3025 (Part 23)	—
xxiii)	Total hardness (as CaCO ₃), mg/l, <i>Max</i>	200	600	IS 3025 (Part 21)	—
xxiv)	Zinc (as Zn), mg/l, <i>Max</i>	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, <i>Max</i>	0.003	No relaxation	IS 3025 (Part 41)	—
ii)	Cyanide (as CN), mg/l, <i>Max</i>	0.05	No relaxation	IS 3025 (Part 27)	—
iii)	Lead (as Pb), mg/l, <i>Max</i>	0.01	No relaxation	IS 3025 (Part 47)	—
iv)	Mercury (as Hg), mg/l, <i>Max</i>	0.001	No relaxation	IS 3025 (Part 48)/ Mercury analyser	—
v)	Molybdenum (as Mo), mg/l, <i>Max</i>	0.07	No relaxation	IS 3025 (Part 2)	—
vi)	Nickel (as Ni), mg/l, <i>Max</i>	0.02	No relaxation	IS 3025 (Part 54)	—
vii)	Pesticides, µg/l, <i>Max</i>	See Table 5	No relaxation	See Table 5	—
viii)	Polychlorinated biphenyls, mg/l, <i>Max</i>	0.000 5	No relaxation	ASTM 5175*	—
ix)	Polynuclear aromatic hydrocarbons (as PAH), mg/l, <i>Max</i>	0.000 1	No relaxation	APHA 6440	or APHA 6630 —
x)	Total arsenic (as As), mg/l, <i>Max</i>	0.01	0.05	IS 3025 (Part 37)	—
xi)	Total chromium (as Cr), mg/l, <i>Max</i>	0.05	No relaxation	IS 3025 (Part 52)	—
xii)	Trihalomethanes:				
a)	Bromoform, mg/l, <i>Max</i>	0.1	No relaxation	ASTM D 3973-85* or APHA 6232	—
b)	Dibromochloromethane, mg/l, <i>Max</i>	0.1	No relaxation	ASTM D 3973-85* or APHA 6232	—
c)	Bromodichloromethane, mg/l, <i>Max</i>	0.06	No relaxation	ASTM D 3973-85* or APHA 6232	—
d)	Chloroform, mg/l, <i>Max</i>	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 source 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, <i>Max</i>	0.1	No relaxation	Part 2	—
b)	Beta emitters Bq/l, <i>Max</i>	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 (4)	AOAC/ ISO (5)
(1)	(2)	(3)		
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)	Chlorpyrifos	30	525.2, 8141 A	—
viii)	Delta HCH	0.04	508	—
ix)	2,4- Dichlorophenoxyacetic acid	30	515.1	—
x)	DDT (<i>o</i> , <i>p</i> and <i>p</i> , <i>p</i> – 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 Water¹⁾
(Clause 4.1.1)

SI No.	Organisms	Requirements
(1)	(2)	(3)
i)	<i>All water intended for drinking:</i>	
	a) <i>E. coli</i> or thermotolerant coliform bacteria ^{2), 3)}	Shall not be detectable in any 100 ml sample
ii)	<i>Treated water entering the distribution system:</i>	
	a) <i>E. coli</i> 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)	<i>Treated water in the distribution system:</i>	
	a) <i>E. coli</i> 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.

Colour (Hazen units)	
IS 10500-1991	Desirable : 5 Hz. , Permissible : 25 Hz.
Risks or effects	Visible tint, acceptance decreases
Sources	Tannins, Iron, Copper, Manganese Natural deposits
Treatment	Filtration, Distillation, Reverse osmosis, Ozonisation

Odour	
IS 10500-1991	Unobjectionable
Risks or effects	Rotten egg, Musty, Chemical
Sources	Chlorine, Hydrogen sulfide, Organic matter, Septic contamination, Methane gas
Treatment	Activated carbon, Air stripping, oxidation, Filtration

pH	
IS 10500-1991	Desirable :6.5 – 8.5, Permissible :No relaxation
Risks or effects	Low pH - corrosion, metallic taste High pH – bitter/soda taste, deposits
Sources	Natural
Treatment	Increase pH by soda ash Decrease pH with white vinegar / citric acid

Total Dissolved Solids (TDS)	
IS 10500-1991	Desirable : 500 mg/l , Permissible : 2000 mg/l
Risks or effects	Hardness, scaly deposits, sediment, cloudy colored water, staining, salty or bitter taste, corrosion of pipes and fittings
Sources	Livestock waste, septic system Landfills, nature of soil Hazardous waste landfills Dissolved minerals, iron and manganese
Treatment	Reverse Osmosis, Distillation, deionization by ion exchange ³⁵

Hardness	
IS 10500-1991	Desirable :300 mg/L , Permissible : 600 mg/L
Risks or effects	Scale in utensils and hot water system, soap scums
Sources	Dissolved calcium and magnesium from soil and aquifer minerals containing limestone or dolomite
Treatment	Water Softener Ion Exchanger , Reverse Osmosis

Alkalinity	
IS 10500-1991	Desirable : 200 mg/L , Permissible : 600 mg/L
Risks or effects	Low Alkalinity (i.e. high acidity) causes deterioration of plumbing and increases the chance for many heavy metals in water are present in pipes, solder or plumbing fixtures.
Sources	Pipes, landfills Hazardous waste landfills
Treatment	Neutralizing agent

Iron, Fe	
IS 10500-1991	Desirable : 0.3 mg/l , Permissible : 1.0 mg/l
Risks or effects	Brackish color, rusty sediment, bitter or metallic taste, brown-green stains, iron bacteria, discolored beverages
Sources	Leaching of cast iron pipes in water distribution systems Natural
Treatment	Oxidizing Filter , Green-sand Mechanical Filter

Manganese, Mn	
IS 10500-1991	Desirable : 0.1 mg/l , Permissible : 0.3 mg/l
Risks or effects	Brownish color, black stains on laundry and fixtures at .2 mg/l, bitter taste, altered taste of water-mixed beverages
Sources	Landfills Deposits in rock and soil
Treatment	Ion Exchange , Chlorination, Oxidizing Filter , Green-sand Mechanical Filter

Sulphate, SO₄	
IS 10500-1991	Desirable : 200 mg/l, Permissible : 400 mg/l
Risks or effects	Bitter, medicinal taste, scaly deposits, corrosion, laxative effects, "rotten-egg" odor from hydrogen sulfide gas formation
Sources	Animal sewage, septic system, sewage By-product of coal mining, industrial waste Natural deposits or salt
Sulphate Treatment	Ion Exchange , Distillation , Reverse Osmosis

Nitrate, NO₃	
IS 10500-1991	Desirable : 45 mg/l, Permissible : 100 mg/lit
Risks or effects	Methemoglobinemia or blue baby disease in infants
Sources	Livestock facilities, septic systems, manure lagoons, fertilizers Household waste water, fertilizers Fertilizers Natural Deposits
Treatment	Ion Exchange, Distillation, Reverse Osmosis

Fluoride, F	
IS 10500-1991	Desirable : 1.0 mg/l, Permissible : 1.5 mg/l
Risks or effects	Brownish discoloration of teeth, bone damage
Sources	Industrial waste Geological
Treatment	Activated Alumina, Distillation, Reverse Osmosis, Ion Exchange

Arsenic, As	
IS:10500-1991	Desirable: 0.05 mg/l Permissible: No relaxation
Risks or effects	Weight loss; Depression; Lack of energy; Skin and nervous system toxicity
Sources	Previously used in pesticides (orchards) Improper waste disposal or product storage of glass or electronics, Mining Rocks
Treatment	Activated Alumina Filtration, Reverse Osmosis, Distillation, Chemical Precipitation, Ion exchange, lime softening

Chromium, Cr	
IS 10500-1991	Desirable : 0.05 mg/l, Permissible : No relaxation
Risks or effects	Skin irritation, skin and nasal ulcers, lung tumors, gastrointestinal effects, damage to the nervous system and circulatory system, accumulates in the spleen, bones, kidney and liver
Sources	Septic systems Industrial discharge, mining sites
Treatment	Ion Exchange, Reverse Osmosis, Distillation

Chloride, Cl	
IS 10500-1991	Desirable : 250 mg/l , Permissible : 1000 mg/l
Risks or effects	High blood pressure, salty taste, corroded pipes, fixtures and appliances, blackening and pitting of stainless steel
Sources	Fertilizers Industrial wastes Minerals, seawater
Treatment	Reverse Osmosis , Distillation, Activated Carbon

Copper, Cu	
IS 10500-1991	Desirable : 0.05 mg/l, Permissible : 1.5 mg/l
Risks or effects	Anemia, digestive disturbances, liver and kidney damage, gastrointestinal irritations, bitter or metallic taste; Blue-green stains on plumbing fixtures
Sources	Leaching from copper water pipes and tubing, algae treatment Industrial and mining waste, wood preservatives Natural deposits
Treatment	Ion Exchange, Reverse Osmosis, Distillation

Cyanide	
IS 10500-1991	Desirable : 0.05 mg/l, Permissible : No relaxation
Risks or effects	Thyroid, nervous system damage
Sources	Fertilizer Electronics, steel, plastics mining
Treatment	Ion Exchange, Reverse Osmosis, Chlorination

Lead, Pb	
IS 10500-1991	Desirable : 0.05 mg/l, Permissible : No relaxation
Risks or effects	Reduces mental capacity (mental retardation), interference with kidney and neurological functions, hearing loss, blood disorders, hypertension, death at high levels
Sources	Paint, diesel fuel combustion Pipes and solder, discarded batteries, paint, leaded gasoline Natural deposits
Treatment	Ion Exchange, Activated Carbon , Reverse Osmosis, Distillation

Mercury, Hg	
IS 10500-1991	Desirable : 0.001 mg/l, Permissible : No relaxation
Risks or effects	Loss of vision and hearing, intellectual deterioration, kidney and nervous system disorders, death at high levels
Sources	Fungicides Batteries, Mining, electrical equipment, plant, paper and vinyl chloride Natural deposits
Treatment	Reverse Osmosis, Distillation

Zinc, Zn	
IS 10500-1991	Desirable :5 mg/l, Permissible : 15 mg/l
Risks or effects	Metallic taste
Sources	Leaching of galvanized pipes and fittings, paints, dyes Natural deposits
Treatment	Ion Exchange Water Softeners, Reverse Osmosis, Distillation

Total Coliform Bacteria	
IS 10500-1991	95% of samples should not contain coliform in 100 ml 10 coliform / 100ml
Risks or effects	Gastrointestinal illness
Sources	Livestock facilities, septic systems, manure lagoons Household waste water Naturally occurring
Treatment	Chlorination , Ultraviolet, Distillation, Iodination

E.coliform Bacteria	
IS 10500-1991	Nil / 100ml
Risks or effects	Gastrointestinal illness
Sources	Livestock facilities, septic systems, manure lagoons Household waste water Naturally occurring
Treatment	Chlorination , Ultraviolet, Distillation, Iodination

HEALTH EFFECTS OF CHEMICAL PARAMETERS

Parameter	General & Health effect
Total dissolved solids	Undesirable taste; gastro intestinal irritations; corrosion or incrustation
PH	Affects mucous membrane; bitter taste; corrosion; affects aquatic life
Alkalinity	Boiled rice turns yellowish
Hardness	Poor lathering with soap; deterioration of the quality of clothes; scale forming; skin irritation; boiled meat and food become poor in quality
Calcium	Poor lathering and deterioration of the quality of clothes; incrustation in pipes; scale formation
Magnesium	Poor lathering and deterioration of clothes; with sulfate laxative
Iron	Poor or sometimes bitter taste, color and turbidity; staining of clothes materials; iron bacteria causing slime
Manganese	Poor taste, color and turbidity; staining; black slime

HEALTH EFFECTS OF CHEMICAL PARAMETERS

Parameter	General & Health effect
Aluminum	Neurological disorders; Alzheimer's disease
Copper	Liver damage; mucosal irritation, renal damage and depression; restricts growth of aquatic plants
Zinc	Astringent taste; opalescence in water; gastro intestinal irritation; vomiting, dehydration, abdominal pain, nausea and dizziness
Ammonia	Indicates pollution; growth of algae
Nitrite	Forms nitrosoamines which are carcinogenic
Nitrate	Blue baby disease (methemoglobineamia); algal growth
Sulfate	Taste affected; laxative effect; gastro intestinal irritation
Chloride	Taste affected; corrosive
Fluoride	Dental and skeletal fluorosis; non-skeletal

HEALTH EFFECTS OF CHEMICAL PARAMETERS

Parameter	General & Health effect
Phosphate	Algae growth
Arsenic	Toxic; bio-accumulation; central nervous system affected; carcinogenic
Mercury	Highly toxic; causes 'minamata' disease-neurological impairment and renal disturbances; mutagenic
Cadmium	Highly toxic; causes 'itai-itai' disease-painful rheumatic condition; cardio vascular system affected; gastro intestinal upsets and hyper tension
Lead	Causes plumbism-tiredness, lassitudes, abdominal discomfort, irritability, anaemia; bio-accumulation; impaired neurological and motor development, and damage to kidneys
Chromium	Carcinogenic; ulcerations, respiratory problems and skin complaints
Pesticide	Affects central nervous system
Detergent	Undesirable foaming

Thank You