WATER BORNE DISEASES

• Cholera – Vibrio Cholarae or Vibri eltor
• Typhoid – Salmonella Typhi
• Para typhoid – Salmonella paratyphi
• Gastro enteritis – Salmonella group
• Bacillary dysentery – Shigella group
• Leptospirosis - Leptospirae
Detection

Coliform Test

Gas formation test  Plate Count test

MPN – Most Probable Number
VIRUS (*Parasite*)

- Flagella
- Cell wall
- Cell fluid
- Animal Virus
- Plant Virus
- Bacteriophage
VIRAL DISEASES

- **Polio Virus** (Poliomyelitis) *
- **Adeno virus** (Hepatitis)*
- **Coxsackie Virus** (Common Cold)**
- **Echo Virus** (acute diarrhea)*
- **Entero virus** (Viral fever) **
- * -**Water borne**
- **- Air borne**
Hap A & B

• Infection hepatitis – (Cataharl jaundice)

Hap E, F are from infected blood

- One drop of infected blood can infect 1000 persons
Viral Count – only on host cell

Plate count test with endo media

Monkey kidney cells?

Emulsified frozen cells are available now
Protozoa

Amoebic dysentery — Cysts of Entamoeba hystolitica
– Lever abscessis, acute diarrhea
– Long term effects on brain cells
– As per WHO 30 % of Asians are carriers

Balantidiasis- Balantidium protozoa

Giardiasis — also known as flagellate dysentery
Good Water - pH 7.2 to 7.5

- Should retain bicarbonate alkalinity for taste
- pH is an indicator of pollution
- pH above 9 indicates industrial pollution
Cluster of septic tanks

Excess Nitrates

Agricultural run off

- > 50 ppm – Mathamoglobinemia
  (blue baby syndrome – Infant disease)

Why infants?
METHAEMOGLOBINEMIA

It is characterized by reduced ability of the blood to carry oxygen because of reduced levels of normal haemoglobin.

Infants are most often affected, and may seem healthy, but show signs of blueness around the mouth, hands, and feet, hence the common name “blue baby syndrome”.

Children may also have trouble breathing as well as vomiting and diarrhoea. In extreme cases, there is marked lethargy, an increase in the production of saliva, loss of consciousness and seizures. Some cases may be fatal.

In the body nitrates are converted to nitrites. The nitrites react with haemoglobin in the red blood cells to form methaemoglobin, affecting the blood's ability to carry enough oxygen to the cells of the body. Bottle-fed infants less than three months of age are particularly at risk.

The haemoglobin of infants is more susceptible and the condition is made worse by gastrointestinal infection. Older people may also be at risk because of decreased gastric acid secretion.
Fluorides – from minerals & Ind. Wastes

Upto 1 ppm – preserves enamel of teeth

>1.5 ppm – *dental fluorosis*

>10 ppm – *skeletal fluorosis*

Fluoride map of India
– 150 potential risk zones
Dental Fluorosis

Fig. 6 Note the white spots on the teeth enamel - yellow and slightly brown spots can also be seen.

Fig. 7 Note the yellowish-brown discolouration seen as horizontal streaks on the surface of the enamel.

Fig. 8 Brown-black discolouration seen at the tip of the teeth.

Fig. 9 Enamel surface gets pitted in dental fluorosis - note the pits on the enamel surface.
Dental Fluorosis
Skeletal Fluorosis

Fig. 4 A victim of skeletal fluorosis requires help in his movements as his bones and joints have undergone considerable changes due to the disease.

Fig. 5 Two pieces of backbones are shown; one from a normal and the other from a subject died of Skeletal fluorosis. Normal piece of vertebrae is on the right and the one from an individual afflicted with fluorosis is on the left. The fluorosed bone is dense, bone mass is increased, individual Vertebra cannot be distinguished. The normal bone clearly shows that there are 6 vertebrae.
Skeletal Fluorosis
Heavy metals & Toxic inorganics

- Lead (pb)
- Copper (cu)
- Zinc (zn)
- Mercury (Hg)
- Phenols
- Cyanide (CN)

From metal Plating Industries

Cumulative toxins

Carcenogenic effects
Arsenic (As)

Mainly in ground water due to arsenic leaching

Cumulative toxin above 0.1 mg/L

- Lead to Secondary Arsenosis

Levels upto 4mg/L are detected in ground water of West Bengal & East Bengal (Bangladesh)
Arsenosis
Arsenosis
Arsenosis
Arsenosis
Mutations

- HIV Virus
- Bird flu
- Chickengunya ???
- $H_1N_1$ Virus ???
General Problems :- Third World

1. Eutrophication of Navigation canals & lakes
2. Plastics choking Sewers (Mumbai ??)
3. Excessive use of pesticides and fertilizers – ground water contamination
4. After pollution of water pipes needing replacement
5. Abuse of water courses
WATER QUALITY
Attributes of Drinking Water

Aesthetic: Free from color, taste, odor and pleasing (Physical perception – subjective)

Safety: Bacteriological (Free from pathogens-disease causing microorganism)

Chemical (Free from toxicants – natural & anthropogenic)
Quality of water

Water sources
1) Ground water
   (Fe and Mn)

2) Surface water
   (Pathogens, organic inorganic pollutants)

Contd....
Quality of water ....contd

3) Lake water (algal growth, taste and odor)

4) Sea water (salinity, TDS)

5) Treated Effluents (pathogens, nutrients)
Raw Water Characteristics

• Physical Parameters
  Characteristics that respond to the senses of sight, touch, taste or smell.

• Chemical Parameters
  Characteristics which are related to the solvent capabilities of water

• Biological parameters
  All members of biological community are, to some extent, water quality parameters
Physical Parameters

• Suspended Solids
• Turbidity
• Colour
• Odour
• Taste
• pH
• Conductivity
• Turbidity:
  - responsible for shielding microorganisms making disinfection ineffective
  - measured as NTU using a turbidi meter
  - works on the principle of the Tyndal effect

• Color:
  due to humic acids and industrial wastes
  - measured in cobalt discs
  - Indicator of pollution
• Chlorides:

✓ Due to minerals and sea water intrusion

✓ Upto 250 mg/l permissible

• Hardness:

✓ Results in scale formation in boilers and brackishness and excess detergent consumption

✓ Due to divalent cat ions of ca++ & Mg++
• Dissolved oxygen:
  ✓ Indicates freshness of water
  Desirable – 7 to 8 mg/l

• Alkalinity:
  ✓ Bicarbonate alkalinity adds taste to water
    ( pH – 7 to 7.5 )

  Hydroxyl Alkalinity ( due to industrial wastes)
  ( pH above 8.5 is toxic )
• Nitrates:
Above 50mg/l results in mathemoglobinemia (blue baby syndrome)
- Affects infants below 2 years

Fluorides:
up to 1mg/l helps in tooth enamel
✓>1.5 mg/l results in dental fluorosis
✓>10 mg/l results in skeletal fluorosis

M.P.N.: (Most Probable No)
Denotes the presence of pathogens
Extent of treatment for different usages

Beneficial uses:-

1. Domestic water – high quality
2. Industrial
   - Process water – high quality
   - Production – high quality
   - Transport water – low quality
   - House keeping – low quality
3. Recreational : Free from pathogens
4. Agricultural : TDS, SAR, heavy metals

TDS: Total Dissolved Solids
SAR: Sodium Adsorption Ratio
ENVIRONMENTAL
STANDARDS & LEGISLATIONS
Definition

• An **environmental standard** is a policy guideline that regulates the effect of human activity upon the environment.

• Environmental standards is a set of quality conditions that are to be adhered or maintained for a particular environmental component and function.

• The different environmental activities have different concerns and therefore different standards.
INDIA IS THE FIRST COUNTRY IN THE WORLD TO PROVIDE PROTECTION AND IMPROVEMENT OF THE ENVIRONMENT IN ITS CONSTITUTION

**ARTICLE 48-A**

RESPONSIBILITY OF STATES TO PROTECT AND IMPROVE THE ENVIRONMENT

**ARTICLE 51-A**

IT IS A FUNDAMENTAL DUTY OF EVERY CITIZEN TO PROTECT & IMPROVE THE ENVIRONMENT
The United Nations Conference on Human Environment held in 1972 at Stockholm can be termed as the first international awakening to the problems of environmental pollution. All the participating countries decided and resolved to take steps to preserve the resources of the earth, including the quality of Water & Air.
Desirable water use

Public health and ecological water quality

Inputs
Point sources and Non point sources

Aquatic ecosystem
(River/Lake)
Reaction, Transport

Water quality concentration
Desired vs actual

Environmental Engineering control

Actual Concentration ≠ Desired Concentration

WATER QUALITY MANAGEMENT
<table>
<thead>
<tr>
<th>S. No.</th>
<th>Manifestation of Problems</th>
<th>Water use interference</th>
<th>Water quality problem</th>
<th>Water quality variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Fish Kills, nuisance odors</td>
<td>Fishery, recreation, ecological health</td>
<td>Low DO</td>
<td>B.O.D, NH₃, organic nitrogen, organic solids, photo plankton, DO</td>
</tr>
<tr>
<td>2.</td>
<td>Disease Transmission</td>
<td>Water supply, Recreation.</td>
<td>High Bacteria levels</td>
<td>Total coli form bacteria, fecal coli form bacteria, fecal streptococci Viruses</td>
</tr>
<tr>
<td>3.</td>
<td>Taste and odors</td>
<td>Water supply, recreation, ecological health</td>
<td>Excessive plant growth</td>
<td>Nitrogen, phosphorous, phytoplankton.</td>
</tr>
<tr>
<td>4.</td>
<td>Carcinogens in water</td>
<td>Water supply</td>
<td>High toxic chemical Levels</td>
<td>Metals, radioactive substances, pesticides, herbicides, toxic product chemicals</td>
</tr>
<tr>
<td>Designated-Best-Use</td>
<td>Class of water</td>
<td>Criteria</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------------------------------------------------</td>
<td>----------------</td>
<td>--------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drinking Water Source without conventional treatment but after disinfection</td>
<td>A</td>
<td>• Total Coli forms Organism MPN/100ml shall be 50 or less</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• pH between 6.5 and 8.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Dissolved Oxygen 6 mg/l or more</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Biochemical Oxygen Demand 5 days 20°C 2 mg/l or less</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outdoor bathing</td>
<td>B</td>
<td>• Total Coli forms Organism MPN/100ml shall be 500 or less</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• pH between 6.5 and 8.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Dissolved Oxygen 5 mg/l or more</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Biochemical Oxygen Demand 5 days 20°C 3 mg/l or less</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drinking water source after conventional treatment and disinfection</td>
<td>C</td>
<td>• Total Coli forms Organism MPN/100ml shall be 5000 or less</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• pH between 6 to 9</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Dissolved Oxygen 4 mg/l or more</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Biochemical Oxygen Demand 5 days 20°C 3 mg/l or less</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propagation of Wild life and Fisheries</td>
<td>D</td>
<td>• pH between 6.5 to 8.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Dissolved Oxygen 4 mg/l or more</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Free Ammonia (as N) 1.2 mg/l or less</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigation, Industrial Cooling, Controlled Waste disposal</td>
<td>E</td>
<td>• pH between 6.0 to 8.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Electrical Conductivity at 25°C micro mhos/cm Max. 2250</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Sodium absorption Ratio Max. 26</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Boron Max. 2 mg/l</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
STANDARDS AND CRITERIA

• Environment (Air/Water) quality criteria are cause-effect relationships, observed experimentally or in field, or exposed to various levels of specific pollutants.

• The Air/Water quality criteria are descriptive.

• They describe effects that can be expected to occur whenever the level of a pollutant reaches or exceeds a specific concentration for a particular time period in air or water environment.

• Criteria will change as new information becomes available.
Environmental standards are prescriptive.

It prescribe pollutant levels that cannot legally be exceeded during a specific time period in a specific geographic area.

The air/water quality standards are based on air/water quality criteria, with added safety factors as desired.
WHO Standards for Drinking Water

- Total Solids: 500 mg/l
- Turbidity: 0.5 NTU
- Iron: 0.3 mg/l
- Manganese: 0.1 mg/l
- Zinc: 0.5 mg/l
- Chlorides: 200 mg/l
- Fluorides: 1 mg/l
- Total Hardness: 150 mg/l
- Arsenic: 0.1 mg/l
- MPN: 1 per 100 ml
### INDIAN STANDARD DRINKING WATER- SPECIFICATION
( BIS 10500 : 1991 )

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Substance or Characteristic</th>
<th>Requirement (Desirable Limit)</th>
<th>Permissible Limit in the absence of Alternate source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Colour, ( Hazen units, Max )</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>2.</td>
<td>Odour</td>
<td>Unobjectionable</td>
<td>Unobjectionable</td>
</tr>
<tr>
<td>3.</td>
<td>Taste</td>
<td>Agreeable</td>
<td>Agreeable</td>
</tr>
<tr>
<td>4.</td>
<td>Turbidity ( NTU, Max)</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>5.</td>
<td>pH Value</td>
<td>6.5 to 8.5</td>
<td>No Relaxsation</td>
</tr>
<tr>
<td>6.</td>
<td>Total Hardness (as CaCO₃) mg/lit.,Max</td>
<td>300</td>
<td>600</td>
</tr>
<tr>
<td>7.</td>
<td>Iron (as Fe) mg/lit.,Max</td>
<td>0.3</td>
<td>1.0</td>
</tr>
<tr>
<td>8.</td>
<td>Chlorides (as Cl) mg/lit.,Max.</td>
<td>250</td>
<td>1000</td>
</tr>
<tr>
<td>9.</td>
<td>Residual,free chlorine,mg/lit.,Min</td>
<td>0.2</td>
<td>--</td>
</tr>
</tbody>
</table>

**Essential characteristics**
<table>
<thead>
<tr>
<th></th>
<th>Desirable Characteristics</th>
<th>Max</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.</td>
<td>Dissolved solids mg/lit,Max</td>
<td>500</td>
<td>2000</td>
</tr>
<tr>
<td>11.</td>
<td>Calcium (as Ca) mg/lit,Max</td>
<td>75</td>
<td>200</td>
</tr>
<tr>
<td>12.</td>
<td>Copper (as Cu) mg/lit,Max</td>
<td>0.05</td>
<td>1.5</td>
</tr>
<tr>
<td>13</td>
<td>Manganese (as Mn)mg/lit,Max</td>
<td>0.10</td>
<td>0.3</td>
</tr>
<tr>
<td>14</td>
<td>Sulfate (as SO₄) mg/lit,Max</td>
<td>200</td>
<td>400</td>
</tr>
<tr>
<td>15</td>
<td>Nitrate (as NO₃) mg/lit,Max</td>
<td>45</td>
<td>100</td>
</tr>
<tr>
<td>16</td>
<td>Fluoride (as F) mg/lit,Max</td>
<td>1.9</td>
<td>1.5</td>
</tr>
<tr>
<td>17</td>
<td>Phenolic Compounds (as C₆H₅OH)mg/lit, Max.</td>
<td>0.001</td>
<td>0.002</td>
</tr>
<tr>
<td>18</td>
<td>Mercury (as Hg)mg/lit,Max</td>
<td>0.001</td>
<td>No relaxation</td>
</tr>
<tr>
<td>19</td>
<td>Cadmiun (as Cd)mg/lit,Max</td>
<td>0.01</td>
<td>No relaxation</td>
</tr>
<tr>
<td>20</td>
<td>Selenium (as Se)mg/lit,Max</td>
<td>0.01</td>
<td>No relaxation</td>
</tr>
<tr>
<td>21</td>
<td>Arsenic (as As) mg/lit,Max</td>
<td>0.05</td>
<td>No relaxation</td>
</tr>
<tr>
<td></td>
<td>Parameter</td>
<td>Max</td>
<td>No relaxation</td>
</tr>
<tr>
<td>---</td>
<td>-----------------------------------------------</td>
<td>-------</td>
<td>---------------</td>
</tr>
<tr>
<td>22</td>
<td>Cyanide (as CN) mg/l,Max</td>
<td>0.05</td>
<td>No relaxation</td>
</tr>
<tr>
<td>23</td>
<td>Lead (as Pb) mg/l,Max</td>
<td>0.05</td>
<td>No relaxation</td>
</tr>
<tr>
<td>24</td>
<td>Zinc (as Zn) mg/l,Max</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>25</td>
<td>Anionic detergents (as MBAS) mg/l,Max</td>
<td>0.2</td>
<td>1.0</td>
</tr>
<tr>
<td>26</td>
<td>Chromium (as Cr⁶⁺) mg/l,Max</td>
<td>0.05</td>
<td>No relaxation</td>
</tr>
<tr>
<td>27</td>
<td>Polynuclear aromatic hydrocarbons (as PAH) g/l,Max</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>28</td>
<td>Mineral Oil mg/l,Max</td>
<td>0.01</td>
<td>0.03</td>
</tr>
<tr>
<td>29</td>
<td>Pesticides mg/l, Max</td>
<td>Absent</td>
<td>0.001</td>
</tr>
<tr>
<td>30</td>
<td>Radioactive Materials</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>i. Alpha emitters Bq/l,Max</td>
<td>--</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>ii. Beta emitters pci/l,Max</td>
<td>--</td>
<td>1.0</td>
</tr>
<tr>
<td>31</td>
<td>Alkalinity mg/lit,Max</td>
<td>200</td>
<td>600</td>
</tr>
<tr>
<td>32</td>
<td>Aluminium (as Al) mg/l,Max</td>
<td>0.03</td>
<td>0.2</td>
</tr>
<tr>
<td>33</td>
<td>Boron mg/lit,Max</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>