Environmental Engineering – Module 1: Water and Water Treatment

1. Sources of Water and Quality Issues

Sources of Water

- **Surface Water:** Rivers, lakes, reservoirs, ponds
- **Groundwater:** Wells, springs, aquifers
- **Rainwater:** Harvested via rainwater collection systems

Water Quality Issues

- Presence of physical, chemical, and biological contaminants such as suspended solids, pathogens, organic matter, heavy metals, and dissolved salts.
- Pollution due to industrial effluents, agricultural runoff, sewage disposal.
- Seasonal and regional variations impact water quality.

2. Water Quality Requirements for Different Beneficial Uses

- **Drinking Water:** Must meet stringent quality standards for potability — safe, potable, free from toxic substances and pathogens.
- **Industrial Water:** Depends on processes; may require specific hardness, pH, and absence of corrosive or scaling substances.
- **Agricultural Water:** May tolerate more impurities but should not harm crops or soil structure.
- **Recreational Water:** Should be free from pathogens and pollutants harmful to human contact.

3. Water Quality Standards

- Standards developed by agencies such as WHO, BIS (Bureau of Indian Standards), EPA, etc.
- Specify permissible limits for parameters like pH, turbidity, total dissolved solids (TDS), microbial counts, heavy metals.
- Example: BIS IS 10500 standard for drinking water quality in India.

4. Water Quality Indices

- Simplifies overall water quality into a single number for easy interpretation.
- Combines multiple parameters weighted by their importance.
- Useful for monitoring and management.

5. Water Safety Plans

- Systematic assessment and management of risks from water source to consumer tap.
- Ensures safe drinking water through hazard identification, risk assessment, control measures, and monitoring.

6. Water Supply Systems

Need for Planned Water Supply Schemes

- To ensure reliable, safe, and adequate water supply for domestic, industrial, and agricultural use.
- Prevents waterborne diseases, promotes public health.

Water Demand

- **Domestic:** Varies by population, lifestyle, climate.
- **Industrial:** Depends on type and scale of industry.
- **Agricultural:** Usually the largest consumer; dependent on crop type and irrigation methods.

Components of Water Supply System

- **Sources:** Surface or groundwater sources.
- **Intake Works:** Facilities to withdraw water from the source.
- **Transmission:** Pipes/ canals for conveying raw water.
- **Treatment Plant:** Removes impurities to meet quality standards.
- **Distribution System:** Network for delivery to consumers.
- **Storage:** Service reservoirs, overhead tanks for balancing supply and demand.

Transmission of Water

- Use of pumps, pipes, gravity flow.
- Design considerations include friction losses, pressure requirements.

Distribution System

- Networks of mains, secondary and tertiary pipes delivering water.
- Designed for adequate pressure and flow to all service areas.

Valves Used in Water Supply Systems

- **Gate Valve:** Full flow, used for isolation.
- **Globe Valve:** Used for flow regulation.
- **Check Valve:** Prevents backflow.
- **Air Valve:** Releases trapped air.
- **Butterfly Valve:** Quick operation, throttling.

Service Reservoirs and Their Design

- Stores water close to demand points.
- Provides buffer during peak demand.
- Design considerations include capacity, structural safety, location, and hydraulic grade.

7. Water Treatment Processes

Aeration

- Removal of dissolved gases (e.g., CO_2), volatile organic compounds.
- Oxidation of iron and manganese.
- Methods: Spray aerators, cascade aerators, diffused aeration.

Sedimentation

- Removal of suspended solids by gravity settling.
- Clarifiers or settling tanks designed for sufficient retention time.

Coagulation and Flocculation

- Addition of chemicals (e.g., alum) to destabilize suspended particles.
- Flocculation helps particles aggregate into larger flocs for easier removal.

Filtration

- Passage through sand or multimedia filters to remove remaining suspended particles.
- Slow sand filters and rapid sand filters are common types.

Disinfection

- Elimination of pathogenic microorganisms.
- Common disinfectants: Chlorine, chloramines, ozone, UV radiation.
- Ensures water is safe for human consumption.

Advanced Treatment Processes

- **Adsorption:** Removal of dissolved organic contaminants (e.g., activated carbon).
- **Ion Exchange:** Removal of hardness ions (Ca^{2+}, Mg^{2+}), heavy metals.
- **Membrane Processes:** Reverse osmosis, ultrafiltration for removal of dissolved salts, pathogens, and micropollutants.

If you want, I can generate detailed notes, diagrams, or solved examples for any of these subtopics. Let me know how you want to proceed!