Unit-2 WATER POLLUTION & WASTE WATER TREATMENT METHOD

Water is one of the most vital sources for all living organisms. Although water is a renewable resource, scarcity of quality water is still a big issue in many parts of the world. We need water for various purposes such as to grow food, keep clean, generate electricity, control fire, and most importantly to stay alive.

Water Resource

1) Saltwater Resources:

- The planet's atmosphere is covered in saltwater. However, when it relates to potable water sources, saltwater is actually ineffective. Desalination plants, though they do operate, are in short supply due to the high energy costs associated with the operation.
- Saltwater fish is indeed a staple of many people's diets around the world. In addition, tidal waters have been used to generate hydroelectric power.

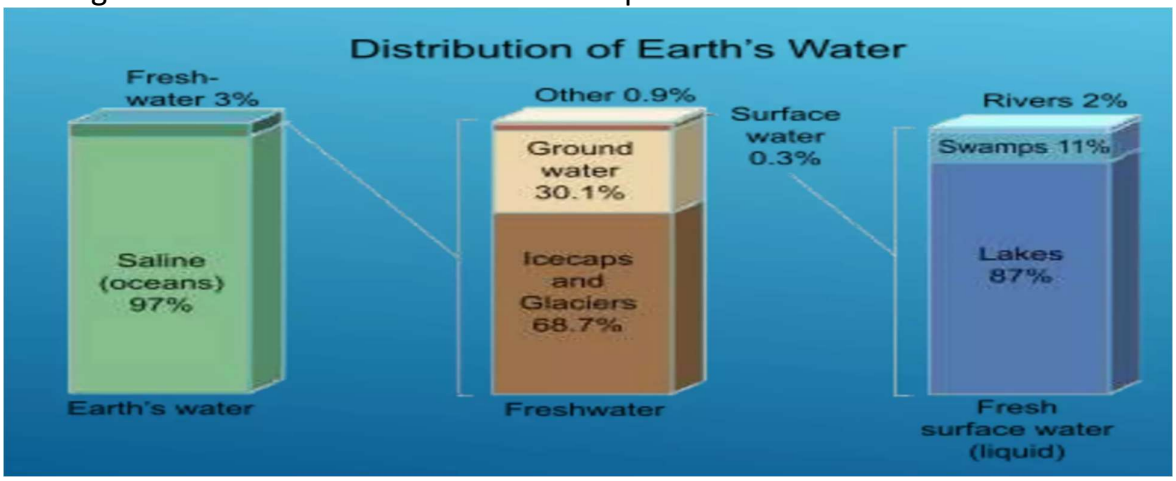
2) Groundwater Resources:

- Of all the freshwater resources, groundwater is the natural resources is perhaps the most abundant. Part of the water that filters down into the soil via layers of dirt, clay, and rock stacks to the uppermost layers, providing water to the plants.
- This water is in the vadose region, which means it is unsaturated. Instead of water, almost all of the pores in the vadose zone are filled with air.
- Humans may use groundwater in an unsustainable manner over an extended period of time without suffering serious repercussions (outcomes

3) Surface Water Resources:

- The water in lakes and rivers is known as surface water. Potable water, recreation, industry, agriculture, transportation, livestock, and hydroelectric energy are all uses for this water.
- Surface water systems have nearly 98 percent of the water used by industry. As a result, maintaining and improving the surface water quality is critical.
- Since surface water provides most of the water used within the United States, water resources information and management are important. It is a chemical, biological, and physical test that determines how acceptable the water is.

Though earth is called the water planet as it is occupied by 75 percent of water, this water cannot be used for domestic purposes.
Ocean water is saline in nature and is not fit for human consumption. Freshwater is just around 2.7 percent of the total water on the earth. Issues such as global warming and perpetuating water pollution have made a considerable amount of impact on making freshwater unfit for human consumption.



Classification of Water

BASED ON ITS USAGE

- Domestic Purposes
- Civic or Public Purposes
- Industrial Purposes
- Business or trade purposes

1) **DOMESTIC PURPOSES**

1-Drinking: Human body contains about 70 percent of water. Consumption of water is required for physiological process such as blood formation, food digestion etc. The quantity of water on an average is about 2 Litres per day for an adult per day. If water for drinking contains undesirable elements it may lead to waterborne diseases like cholera.

2-Cooking: Water required for this purpose will depend upon the stage of advancement of family in particular society in general. The quantity of water an average is about 5 Liters per her per day.

3-Bathing-Water required for bathing purpose will depend on habits of people & type of climate. For an Indian bath 30 to 40 liters per head & for tub bath-50 to 80 liters per head.

4-Washing hands face: Water required for this purpose will depend on habits of people & may roughly be taken as 5 to 10 liters per day

5- Household Sanitary purposes: Water is required for washing clothes, floors utensils, etc. may be assumed to be about 50 to 60 liters per head per day

6- Private Gardening & Irrigation: In case of developed cities there will be particularly no demand of water for this purpose .in underdeveloped cities, the private wells are used to provide water for private gardening & irrigation

7-Domestic Animals & Private vehicles - The amount of water required for use of domestic animals & private vehicles is not much concern to water supply engineer. With growth & development of town, the cattle disappear & commercial stables come into existence. Water required for washing cars & private Vehicles is very low especially in case of poor countries.

2) **CIVIC OR PUBIC PURPOSES**

1) Road Washing - Roads with heavy amount of dust are to be sprinkled with water to avoid inconvenience to users - Even in case of dust proof roads, periodically. washing is necessary. Water required for this purpose maybe 5 liters per day

2) Sanitation Purposes - Water required in cleaning public sanitary blocks, large markets etc. for carrying liquid wastes from houses. Water required for this purpose will depend on growth of civilization will be about 2 to 3 liters per head per day

3) Fire Demand: Usually a fire occurs in factories & stores. Water required for fire fighting skills should be easily available & always kept stored in the storage reservoir. When a fire occurs, pumps installed on trucks are immediate rushed to the site of fire occurrence & these pumps when connected to fire hydrants are capable of throwing water with high pressure.

3) INDUSTRIAL PURPOSES

• Factories: Water required for this process involved in factories will naturally depend on nature of products, size of factory etc. & it has no relation with density of population. Possibility of recycling of water in plant will have appreciable effect on demand of water for project. The quantity of water on average is about 45 Litres per day for an adult per day

- Power stations: They are situated far away from cities & they do not represent serious problem to public water supply
- Railways & Airports: In most of cases, the railways & airports make their own arrangements regarding water requirements. Railways provide 25 to 70 liters of water per head per day. Airport takes 70 liters of water per head per day.

4) BUSINESS OR TRADE PURPOSES

• Some Trades such as Dairies, hotels, laundries, motor garages, restaurants, schools, hospitals, cinema halls, theatres etc require large quantity of water.

ORIGIN, COMPOSITION AND CHARACTERISTICS OF DOMESTIC WASTE WATER

- Wastewater is used water that has been affected by domestic, industrial and commercial use. The composition of all wastewaters is thus constantly changing and highly variable.
- The composition of wastewater is 99.9% water and the remaining 0.1% is solid. This 0.1% contains organic matter, microorganisms and inorganic compounds.
- Domestic wastewater originates from activities such as restroom usage, bathing, food preparation and laundry.
- Commercial wastewater from non-domestic sources, such as beauty salons or auto body repair shops, for example. This wastewater may contain hazardous materials and requires special treatment or disposal.

Organic content of wastewater

- The organic content of wastewater is made up of human feces, protein, fat, vegetable and sugar material from food preparation, as well as soaps.
- Some of this organic content is dissolved into the water and some exist as separate particles.
- The portion of organic material that does not dissolve but remains suspended in the water is known as suspended solids.
- Wastewater is treated to remove as much organic material as possible

Implications for microorganisms

Naturally occurring soil and water bacteria eat the organic waste in wastewater and use it as a food and energy source to grow rapidly. In a natural water environment where there is plenty of oxygen dissolved in the water, aerobic bacteria eat the organic material and form a slime of new bacterial cells and dissolved salt-waste products.

If undiluted wastewater is left on its own, anaerobic bacteria decompose the waste organic material and release odorous gases such as hydrogen sulphide. Odor-free gases such as methane and carbon dioxide can also be released.

Where there is an overwhelming amount of wastewater, all the oxygen will be used up and the anaerobic bacteria will take over, making the water go septic. This is ultimately harmful to fish and other forms of life dependent on oxygen, on occasion creating dead zones.

Inorganic matter

Inorganic minerals, metals and compounds, such as sodium, copper, lead and zinc are common in wastewater from both sewage and wastewater. They can originate from industrial and commercial sources, stormwater, and inflow and infiltration from cracked pipes. Most inorganic substances are stable and cannot be broken down easily by organisms in wastewater.

Nutrients

Excessive nutrients such as phosphorus and nitrogen can cause eutrophication, which can also be toxic to aquatic organisms. This also promotes excessive plant growth and reduces oxygen availability, altering habitats and potentially endangering certain species.

Physical characteristics include:

1) **Temperature**: The normal temperature of sewage is slightly higher then water temperature. Temperature above normal indicate inclusion of hot industrial wastewaters in sewage
2) **Colour**: Fresh sewage is light grey in colour. While the old sewage is dark grey in colour. At a temperature of above 20°c, sewage will change from fresh to old in 2-6 hours.
3) **Odour:** Fresh domestic sewage has a slightly soapy or oil odour. Stale sewage has a pronounced odour of Hydrogen Sulphide (H2S).

4) **Solids**: Solids in sewage may be suspended or in solution solids are a measure of the strength of sewage.

Sewage contains both organic and inorganic chemicals. All the test representing these organic and inorganic constituents come under the heading of chemical characteristics. Test like BOD, COD, NITORGON, PHOSPHOURS, ALKALINITY etc characteristics of sewage.

SOLIDS

1) TOTAL SOLIDS : Include both suspended and dissolved solids. It is measured by evaporating a known volume of sample and the weighting the residue. Results are expressed in mg/lit.
2) SUSPENDED SOLIDS: These are solids which are pertained on a pre-weighed glass fiber filter of 0.45, 103-105°C.
3) DISSOLVED SOLID: Filtrate which has passed thought 0.45µ filter is evaporated in chine dish. The residue gives the dissolved solids.
4) SETTLEABLE SOLIDS: It is the fraction of the solids that will settle in an imhoff cone in 30-60 minutes. These are expressed as mg/1.
5) Non-volatile solids: They give a rough measure of the organic content or in some instances of the concentration of BIOLOGICAL SOLIDS such as bacteria. The determination is made by ignition of residues on 0.45µ filter in a Muffle furnace at 550°C. The residues following the ignition is called non-volatile solids or ash and is rough measure of the mineral content of the waste water. (Note:- Most of the norganic and mineral content do volatilize at 550°C and are quiet resistant)

Bacteria placed in contact with organic matter will utilize it as food source. In the utilization of the organic material, it will eventually be oxidized to stable and products such as CO_2 and H_2O.

BIOCHEMICAL OXYGEN DEMAND

The amount of oxygen required by the bacteria to oxidize the organic matter present in sewage to stable end products is known as biochemical oxygen demand.

Significance: -

1. Used in design of waste water treatment plants.

2. Used to measure efficiently of waste water treatment plant.

CHEMICAL OXYGEN DEMAND

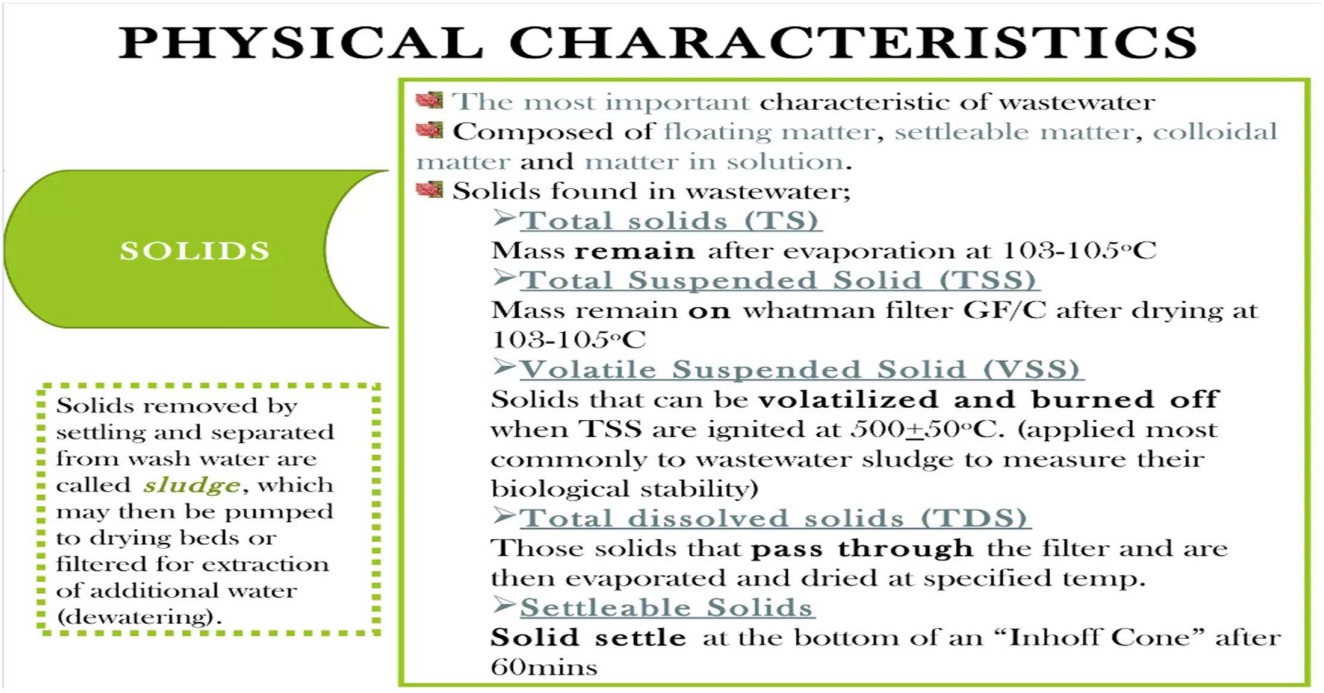
It is the amount of oxygen required to oxidize organic matter chemically (biodegradable and non-biodegradable) by using a strong chemical oxidizing agent. (K_2Cr_2O) in an acidic medium. For a single waste water sample the value of COD will always be greater then BOD.

The oxidant ($K_2Cr_2O_2$) remaining is found out remaining to find K2Cr2O7 considered COD and BOD be interrelated.

Parameter	Range (mg/l)
Total Solids	350 – 1200
Dissolved Solids	250 – 850
Suspended Solids	100 – 350
Setteleable Solids	5 – 20 (ml / l)
BOD	100 – 300
COD	250 – 1000
Total Nitrogen	20 – 85
Alkalinity (as $CaCO_3$)	50 – 200

ORIGIN, COMPOSITION AND CHARACTERISTICS OF INDUSTRIAL WASTEWATER

- Industrial wastewater originates from industrial or commercial manufacturing processes, such as agriculture, and are usually more difficult to treat than domestic wastes.
- Industrial wastewater's composition varies on an industry-by-industry basis.



TURBIDITY

- **Measure of the light** –transmitting properties of the water due to presence **of suspended material such as clay, organic material, plankton** & other particulate material.
- Measured based on **comparison of the intensity of light scattered** by reference suspension under the same condition.
- Unit = Turbidity Unit (TU)@
  Nephlometric Turbidity Unit (NTU)
- Clay @ other suspended particle – **not adversely affect health** but water containing such particles may require treatment.
- Turbidity **excess of 5 TU easily detectable** in a glass of water.

COLOR

- Refer to **degree of absorption of light energy** in visible **spectrum (400-700nm)**
- Causes by ;
  - **dissolved organic material** from decaying vegetation & certain inorganic matter.
  - **excessive blooms** of algae or growth of aquatic microorganisms.
- But its presence is aesthetically objectionable & **needs appropriate treatment**.

Activated sludge and trickling filters can remove a certain percentage of some types of colored matter.

Sometimes color matters needs chemical oxidation procedures for removal.

TASTE & ODOR

- Cause by **foreign matter** (organic compound, inorganic salts @ dissolved gases.
- Odors are usually caused by **gases produced** by the **decomposition of organic matter** or by **substances added** to the wastewater.
- Industrial wastewater may **contain either odorous compounds** or **compounds that produce odor** during the process of wastewater treatment.
- Comes from **domestic, agricultural @ natural sources.**
- At point of use, drinking water should be free from any objectionable taste @ odor.

TEMP.

- Very important parameter - its effect on **chemical reactions and reaction rates**, aquatic life, and the **suitability** of the water for beneficial uses.
- The increase in the rate of biochemical reactions that accompanies an increase in temperature, combined with the **decrease in the quantity of oxygen present** in surface waters, can often cause serious depletions in dissolved oxygen concentration in the summer months.
- Abnormally high temperatures can foster the **growth of undesirable water plants and wastewater fungus**
- Most desirable drinking waters are consistently **cool** & do not have fluctuations of more than a few degrees.
- **Oxygen is less soluble in warm water** than in cold water
- Industrial establishments that use surface water for **cooling-water purposes** are particularly concerned with the temperature of the intake water.
- **Groundwater & surface water** usually meet these criteria.

pH

- The **hydrogen-ion concentration** is an important quality parameter of wastewater.
- The concentration range suitable for the existence of most biological life is quite narrow and critical.
- Wastewater with an adverse concentration of hydrogen ion is difficult to treat by biological means, and if the concentration is not altered before discharge, the **wastewater effluent may alter the concentration in the natural waters.**

CHEMICAL CHARACTERISTICS

CHLORIDE

- Most of water contain.
- Amount presence causes by ;
  - -Leaching of marine sedimentary deposits
  - -Pollution from sea water @ brine @ industrial @ domestic waste.
- Chloride **conc. > 250 mg/L** – noticeable taste
- Domestic water **should contain < 100 mg/L chloride**.

FLUORIDE

- Some areas – water source contain natural fluoride.
- **Excessive fluoride** in drinking water – produce fluorosis (mottling) of teeth.
- Mottled – black sports @ streaks and may become brittle when exposed to large amounts of fluoride.
- Acceptable level for fluoride conc. **between 0.8 – 1.3 mg/L**

S.No	Parameters	Industrial Water
1	Color	Dark yellow
2	pH	8
3	BOD	970mg/l
4	COD	4500mg/l
5	Oil and Grease	12
6	Temperature	33°C
7	Electrical Conductivity	600µScm^{-1}
8	Suspended Solid	150 mg/l
9	Calcium	361 mg/l
10	Magnesium	268 mg/l
11	Sulphate	419 mg/l
12	Iron	12.8 mg/l
13	Lead	0.065 mg/l
14	Zinc	0.26 mg/l
15	Copper	0.135 mg/l
16	Hardness	300 mg/l

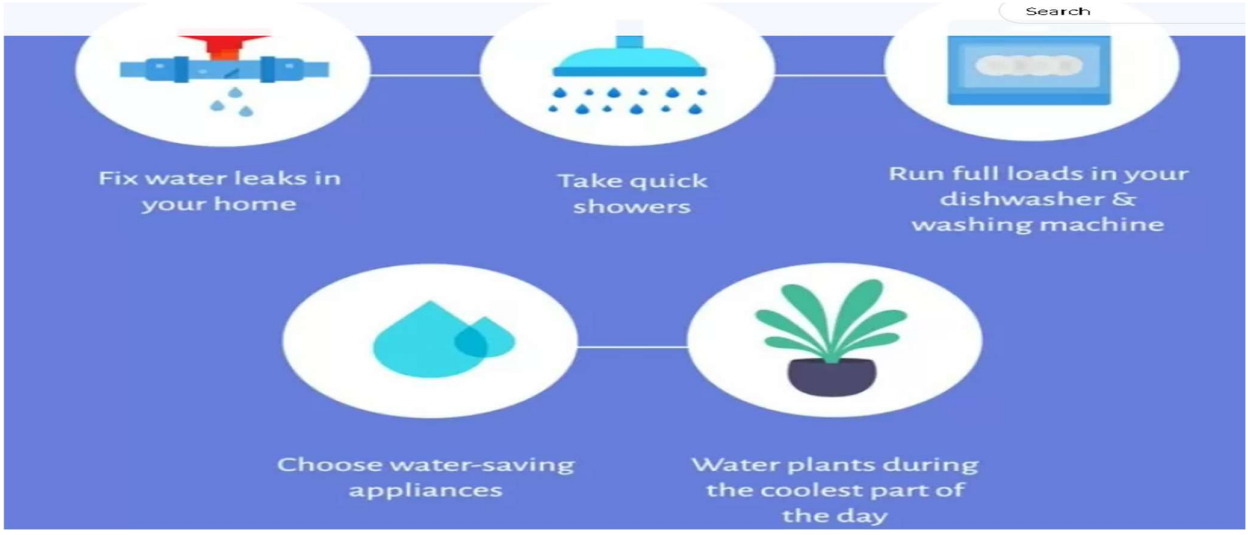
Standards of Water Parameters

S.No	Characteristics	Desirable limit
I	**Physico-chemical Characteristics**	
i)	pH	6.5 to 8.5
ii)	Total Dissolved Solids (TDS)	500 ppm
iii)	Total Hardness (as $CaCO_3$)	300 ppm
iv)	Nitrate	45 ppm
v)	Chloride	250 ppm
vi)	Sulphate	200 ppm
vii)	Fluoride	1 ppm
II	**Biological Characteristics**	
i)	Escherichia Coli (E.Coli)	Not at all
ii)	Coliforms	Not to exceed 10 (In 100 ml water sample)

WATER CONSERVATION

- Water Conservation is the practice of using water efficiently to reduce unnecessary water usage. Water Conservation includes all the policies, activity and strategies to sustainably manage the natural resources of fresh water, to protect the hydrosphere and to meet the current and future human demand.

- Water Conservation is important to us as 97% of earth's mass is covered with water, yet only 1% is available for our use because the remaining water is salty which cannot be used and other portion is blocked by the glaciers and ice caps.
- Population, household size and growth, all affect the quantity of water used. Factors such as climate change have increased pressure on natural water resources especially in manufacturing and agricultural irrigation.
- The goals of water conservation efforts include ensuring the availability of water for future generations, energy conservation as water plumping, delivery and wasteful treatment facilities consume a significant amount of energy.
- We can conserve water by improving water management practises that reduce the use or enhance the beneficial use of water.
- water conservation method includes rainwater harvesting, considering the rational use of groundwater, by making changes in the cultural model as if the crops are grown by farmers under Agro- climatic conditions, there will be no need for excess water.
- Continue checking leaks at home, turning of the faucet while brushing your teeth, considering waterless car washes etc are also some of the ways for conservation of water.



Watershed Management

A watershed is a body of water that includes rivers, lakes, ponds, streams, and estuaries (tides meets the stream). A watershed is a land area that drains or sheds water at a specific waterbody, like a lake or river. Rainwater or melted snow accumulates and moves silt and other elements downstream in the watershed, depositing them in the receiving waterbody.

A small stream's watershed may be a few hectares, whereas a big river's watershed may be many square kilometres. A watershed should ideally be 1,000 to 2,500 hectares in size for proper planning and execution.

Watershed management is a word used to describe the process of implementing land use and water management strategies to maintain and improve the quality of water and other natural resources within a watershed.

Watershed Management Planning:

Watershed management planning is a method of generating a plan or blueprint for protecting and improving the water quality and other natural resources in a watershed. Watershed boundaries frequently extend beyond political boundaries, extending into neighbouring municipalities and/or states.

Objectives of watershed development programs:

- Development of wastelands, areas which are drought-prone, degraded lands and also desert areas while keeping the local needs and site conditions.
- It also helps in promoting the on-ground economic development and also in improving the life standard, socially and economically, of the poor and disadvantaged people living near the program areas.
- This also reduces the effect of natural climatic problems such as drought and geologic processes on humans and plantations.
- Restoring ecological equilibrium by utilising, conserving, and developing natural resources (e.g., land, water, and vegetative cover).

Types of watersheds

Watershed are classified as per their size and land usage:

Macro watershed (> 50,000 Ha)

Sub-watershed (10,000 to 50,000 Ha)

Milli-watershed (1000 to 10,000 Ha)

Micro watershed (100 to 1000 Ha)

Mini watershed (1-100 Ha)

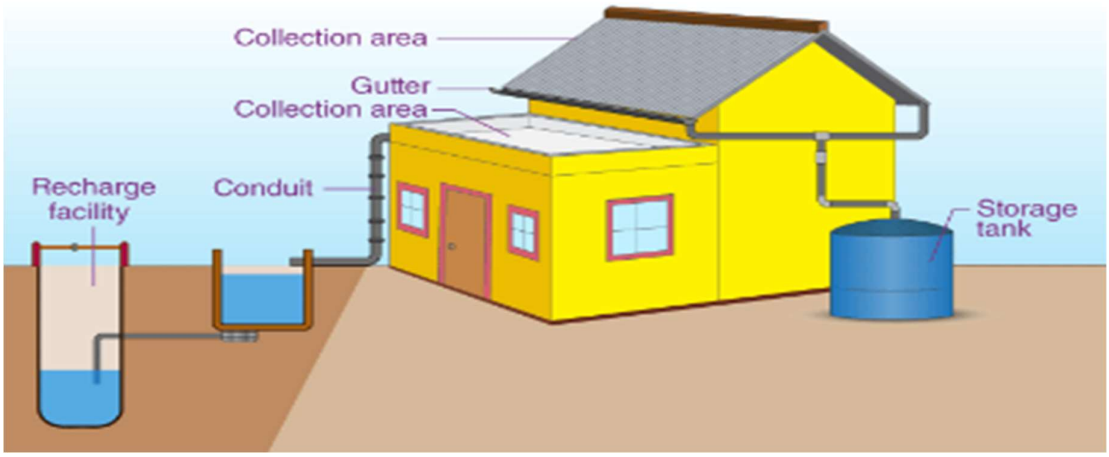
Advantage of Watershed Management

- Watershed management helps regulate pollution of the water and alternative natural resources within the watershed.
- Identifies and Regulates Ecologically Venturous Activities: The activities which happen at a watershed in regular intervals affect the natural resources and water quality.
- Watershed management comprehensively identifies such activities. It makes recommendations to properly address them so that their adverse impacts are often reduced.
- Enhanced Partnership among the stakeholders is rising, which is crucial for the effective management of the land and water resources.
- It is also an economical solution, due to the implementation of watershed management plans when resources are restricted.For example, in places where rainfed is severe, watershed management has proved to double agricultural productivity while aiding the agricultural families through inflated water handiness and diversifying the cropping and farming systems, leading to heterogeneous sources of financial gain.

Conclusion

The process through which land use and water management strategies are practised to maintain and improve water's quality and other natural resources within a watershed through holistically controlling their use is termed as the watershed management.

Watershed development aims to halt and conserve water where it falls, inside each village, under the leadership of the village watershed committee, so that it can be used for longer periods.



Rainwater Harvesting

Rainwater harvesting is the simple process or technology used to conserve rainwater by collecting, storing, conveying and purifying of rainwater that runs off from rooftops, parks, roads, open grounds, etc. for later use.
Broadly there are two ways of harvesting rainwater, namely; surface runoff harvesting and rooftop rainwater harvesting. Rainwater harvesting is the collection and storage of rain for reuse on-site, rather than allowing it to run off. The stored water is used for various purposes, such as gardening, irrigation, etc.

1) Surface Runoff Harvesting
In urban areas, rainwater flows away as surface runoff. This runoff can be caught and used for recharging aquifers by adopting appropriate methods.

2) Rooftop Rainwater Harvesting
It is a system of catching rainwater where it falls. In rooftop harvesting, the roof becomes the catchment, and the rainwater is collected from the roof of the house/building.
It can either be stored in a tank or diverted to an artificial recharge system. This method is less expensive and very useful and, if implemented correctly, helps in augmenting the groundwater level of the area.

The benefits of the rainwater harvesting system are listed below.

- Less cost.
- Helps in reducing the water bill.
- Decreases the demand for water.
- Reduces the need for imported water.
- Promotes both water and energy conservation.
- Improves the quality and quantity of groundwater.
- Does not require a filtration system for landscape irrigation.
- This technology is relatively simple, easy to install and operate.
- It reduces soil erosion, stormwater runoff, flooding, and pollution of surface water with fertilizers, pesticides, metals and other sediments.
- It is an excellent source of water for landscape irrigation with no chemicals, dissolved salts and free from all minerals.

Water (Prevention and Control of Pollution) Act, 1974

The Act came into force in 1974 and is applicable to the states of Assam, Bihar, Madhya Pradesh, Gujrat, Haryana, Tripura, West Bengal, Jammu and Kashmir, Rajasthan, Kerala, and the union territories. It could also be adopted by any state through a resolution passed declaring to adopt the Act. The Water (Prevention and Control) Act, 1974 was introduced to prevent and control water pollution and to restore and maintain the wholesomeness of water for the establishment.

The Act also confers some powers to the established bodies such as the central board and the state board to control pollution of the water bodies.

Agencies for controlling Water Pollution

There are two agencies set up as per the Act for controlling and preventing water pollution.

- Central Board- Central Pollution Control Board
- State Board- State Pollution Control Board.

Waste Water

- Wastewater is used water. It includes substances such as human waste, food scraps, oils, soaps and chemicals.
- In homes, this includes water from sinks, showers, bathtubs, toilets, washing machines and dishwashers.
- Wastewater is defined as any water that has met its intended purpose.
- Wastewater is created by individuals, businesses, agricultural practices like farming, and industrial processes like manufacturing.
- Depending on the source of wastewater, it can be classified into various types.

Two Broad Classifications of Wastewater

Wastewater can be broadly classified into two categories

1)Sewage and

2) Non-sewage.

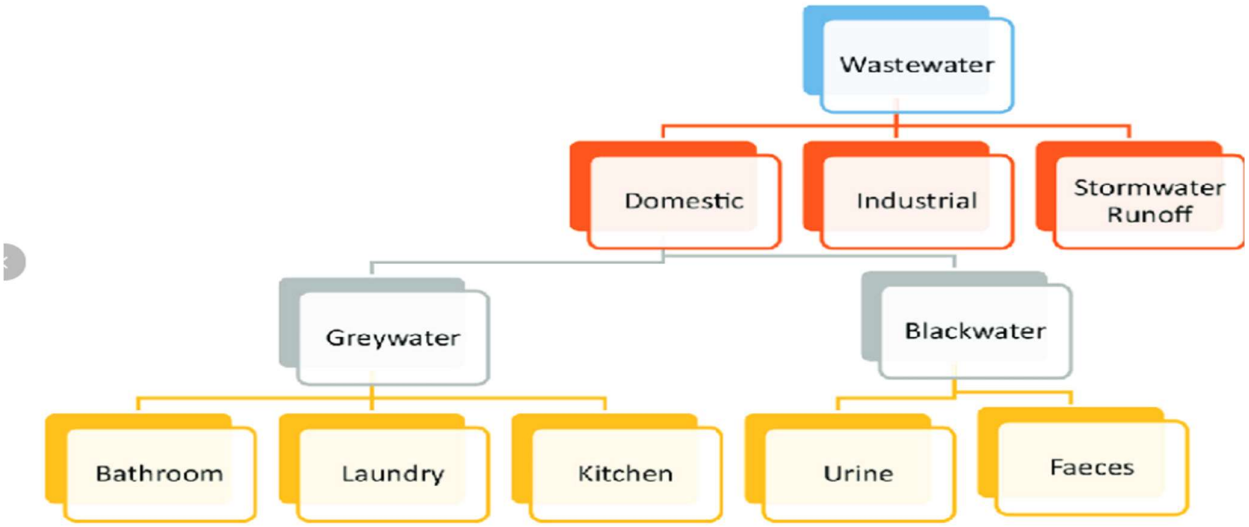
Sewage is any wastewater that contains urine and faeces. It is generated via domestic activities. It refers to the toilet and bathroom water from houses, toilets, schools, hotels, restaurants, hospitals, and other places.

Non-sewage All other types of waste water are referred to as non-sewage. It includes industrial wastewater, rainwater, storm-water, water from washing vessels, clothes, etc. It doesn't contain human wastes and other harmful pathogens.

Wastewater Classification Based on Usage

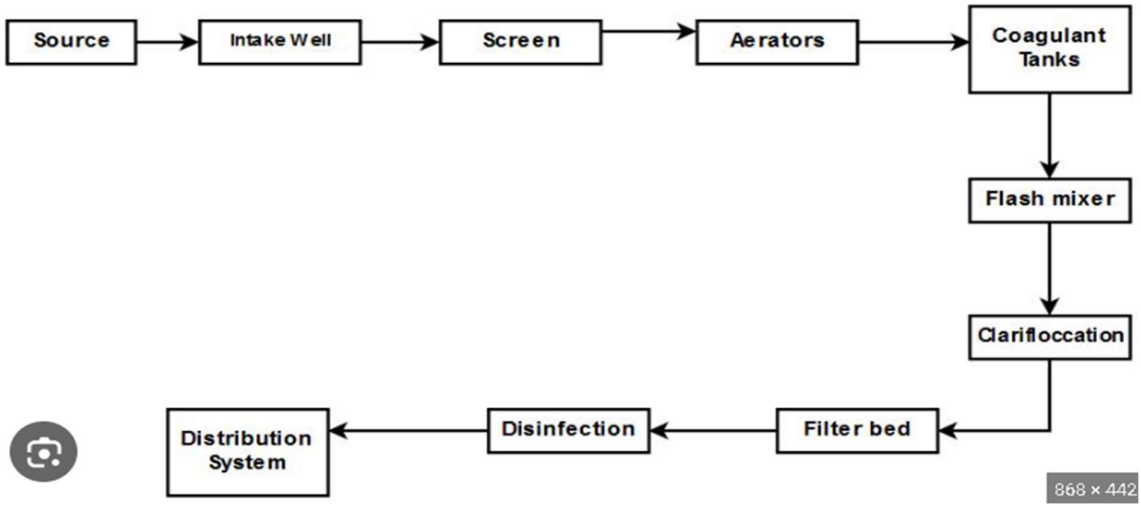
Wastewater can also be further divided into three subcategories based on the source of generation.

1) **Blackwater** It refers to wastewater from toilets, bathrooms, dishwashers, kitchen sinks, and washing machines. It contains urine, faeces, toilet paper, discarded food particles, and other household cleaning agents. This water is highly contaminated and is brimming with disease-causing pathogens. Hence, the name Blackwater.
2) **Greywater** refers to blackwater minus human contaminants. It's wastewater that doesn't contain urine, faecal matter, and food waste. Generally, water from washing machines and other regular household cleanings (minus bathroom and toilet) water is greywater. Water generated from industrial plants is also greywater. Though greywater contains chemicals and other harmful liquids, it's more suitable for recycling and wastewater treatment. It doesn't have any pathogens, thereby making it more ideal for treatment.
3) Yellow water: This is generally pure urine. It is urine that is collected from specific sources. It doesn't contain faecal matter, chemicals, food particles, or other contaminants.



Chemical Oxygen Demand (COD) is a test that measures the amount of oxygen required to chemically oxidize the organic material and inorganic nutrients, such as Ammonia or Nitrate, present in water.

Basic Processes of Water Treatment

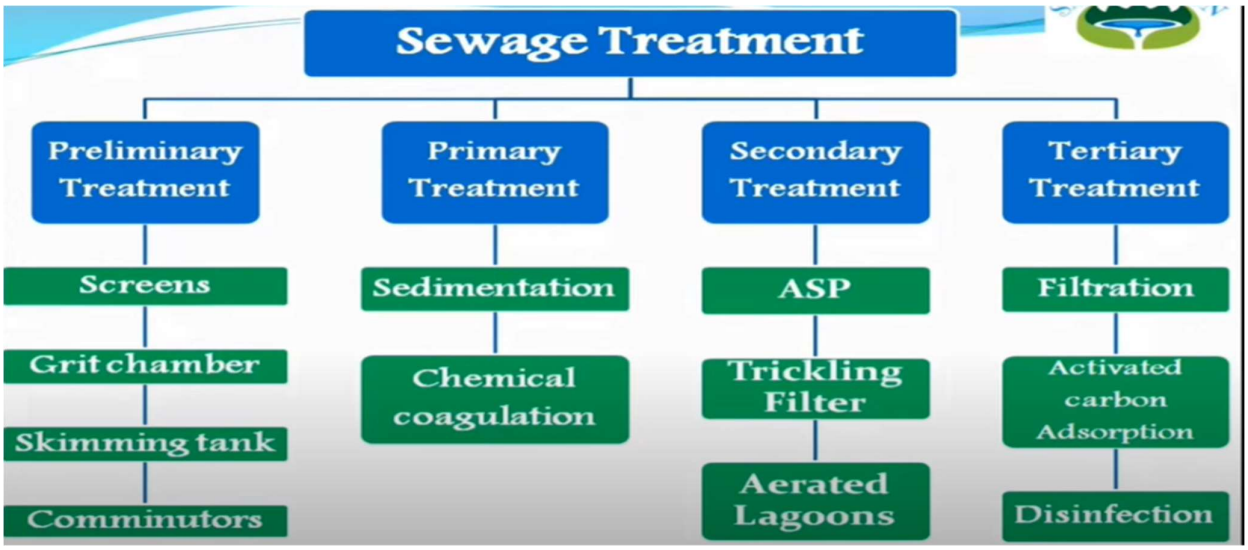


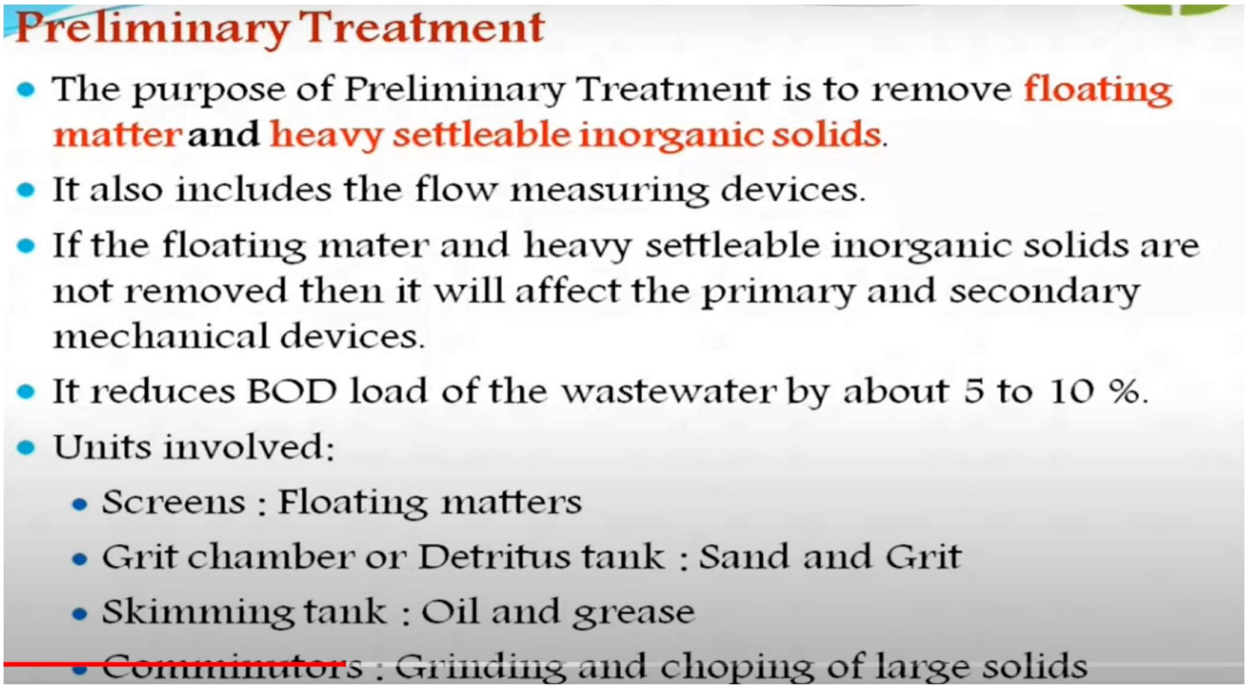
- **Collection:** Before the water can be treated, it must first be collected from lakes, rivers and reservoirs. Most often, the water is transported from the source to the treatment plant via a complex network of pumps and pipelines, though natural means (such as rivers) may be used.
- **Screening**: The first step in the treatment process is to screen the water to remove larger items of suspended materials, such as rubbish, plants, trees, animals and other debris, these are captured and removed via the use of a large metal screen.
- **Chemical addition:** At this point, chemicals are now added to encourage smaller particles of suspended matter to clump together and form “floc”. The chemicals used to achieve this purpose are called coagulants and there are many different products available.
- **Coagulation**: After the coagulant has been added to the water, it must be mixed at varying speeds over a period of time to allow the flocs to form (this part of the process is known as flocculation).
- **Sedimentation and clarification**: Once the flocs have formed, the water is passed over a sedimentation basin. Here, the clumps of floc particles can settle at the bottom of the basin, where they are removed to a disposal pond.
- **Filtration**: With the larger particles taken out of the water, it must now be filtered through a variety of media such as sand, gravel or granular activated carbon to remove the smaller unwanted particles which still persist.
- **Disinfection:** The remaining water has now had the vast majority of its impurities removed, but it may still contain bacteria, viruses and other microorganisms. In order to kill these elements, it must be treated with enough chlorine to be effective but not too much to affect taste or odour.
- **Storage**: The water is now essentially ready for public consumption, but must be stored until demand for it surfaces. It is most commonly stored in underground or overground

tanks. As well as drinking water, there must also be a stored supply of water for emergencies such as fires.

- **Distribution:** The water is finally sent to homes and businesses around the country via a sophisticated system of pumps, tanks, pipelines, hydrants, valves and meters.

Theory of Industrial waste Treatment





Primary Treatment

- The purpose of primary treatment is to remove large suspended solids.
- If preliminary treatment is not given then it removes organic as well as inorganic suspended solids.
- If preliminary treatment is given then it removes organic suspended solids.
- Units involved:
  - Sedimentation
  - Chemical coagulation

Secondary Treatment

- The purpose of secondary treatment is to remove **soluble and colloidal organic matter** which remains after primary treatment.
- Secondary treatment majorly removes biodegradable organic matter by biological action.
- Biological treatment system are designed to maintain a large active mass of bacteria within the system.
- Secondary treatment process classified as:
  - Attached Growth Process; Biological mass is attached to media
  - Suspended Growth Process ; Biological mass in suspension
  - Combined Process

Tertiary Treatment

- The purpose of tertiary treatment is to remove pollutants which are not removed in preliminary, primary and secondary.
- Tertiary treatment removes soluble inorganic compounds such as phosphorous and nitrogen compounds.
- Tertiary treatment aims to reuse the wastewater.

Tertiary treatment units involved:

- Filtration
- Activated carbon Adsorption
- Demineralization
- Disinfection