SUBJECT – ENVIRONMENTAL CHEMISTRY
SUBJECT CODE – CHM-123

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UNIT – 2

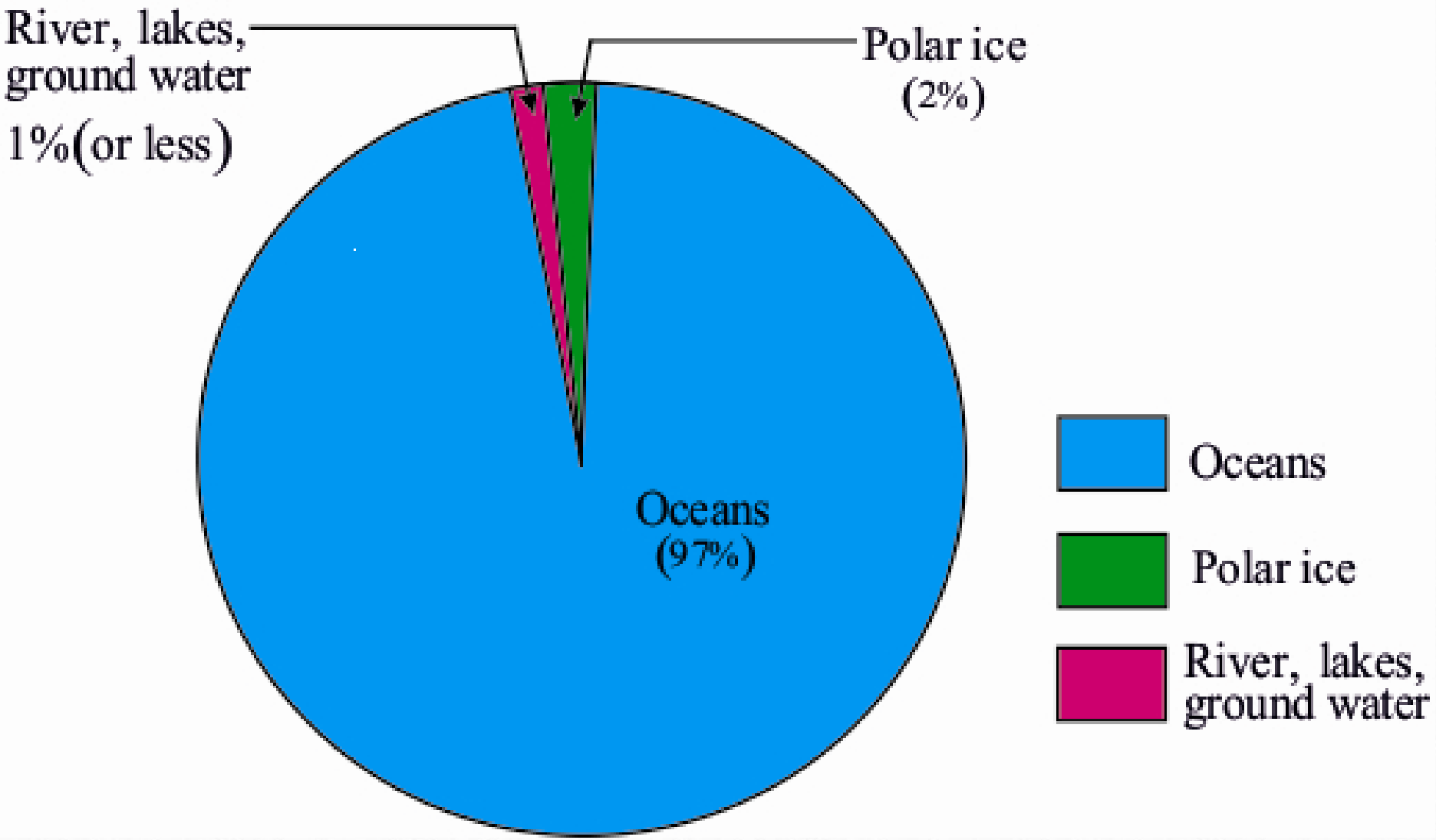
HYDROSPHERE AND WATER POLLUTION

TOPICS TO BE COVERED

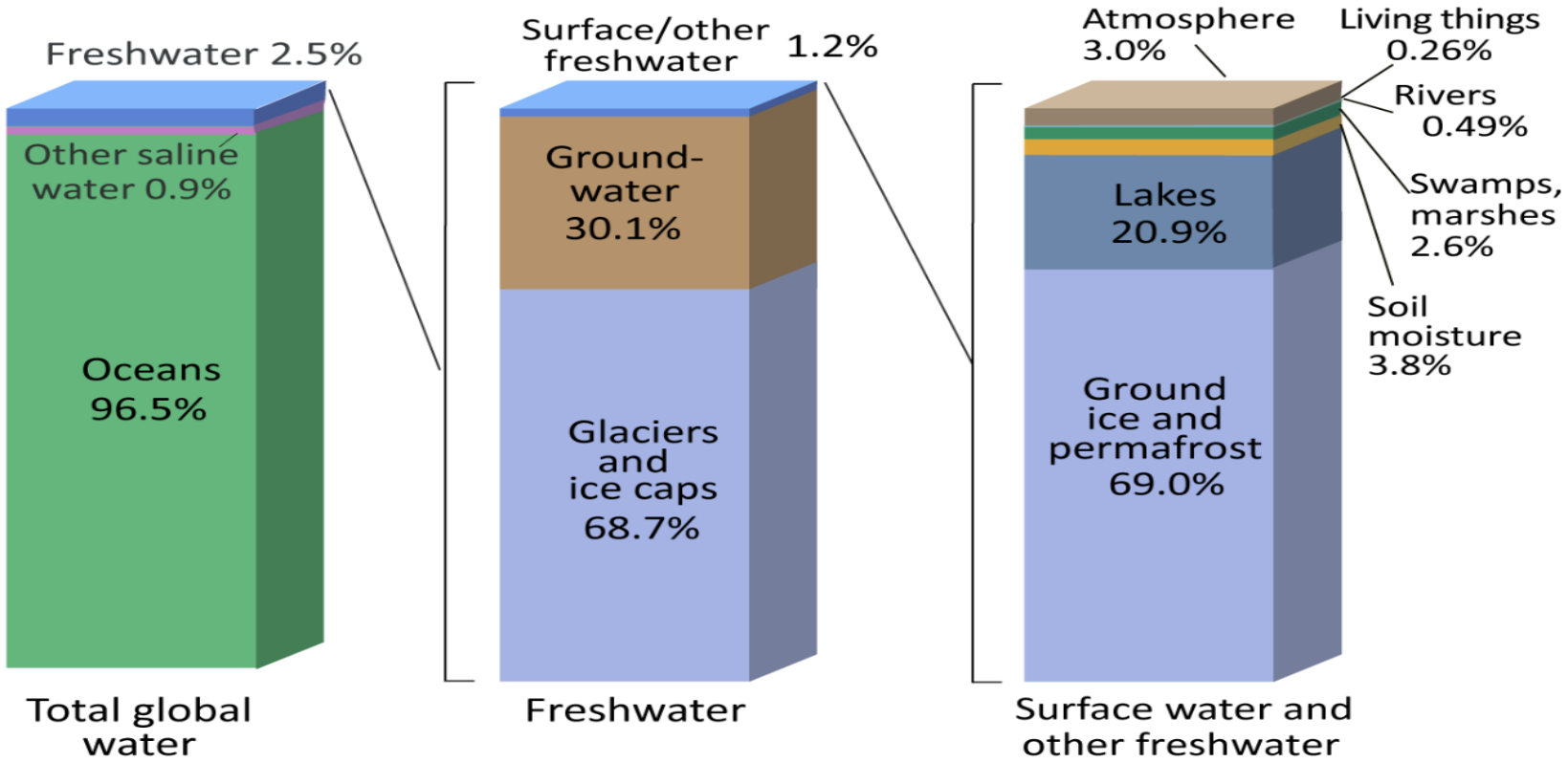
- Characteristics of water: Physical, chemical and biochemical parameters
- Sources of Water pollution: Point and Non-point
- Classification of Water pollutants and their detrimental effects
- Characterization of waste water (including DO, COD, BOD)
- Methods and Equipment used in wastewater treatment-Preliminary, Primary and Secondary (Trickling filters, Aerated lagoon, Activated sludge etc).

Characteristics of Water

- Water is the essential element that makes life possible on earth. Without water there would be no life.
- Although 71% of the earth's surface is covered by water only a small fraction of this water is available to us as fresh water.
- About 97% of the total water available on earth is found in oceans and is too salty for drinking and irrigation.
- The remaining 3% is fresh water. Of this 2.997% is locked in ice caps or glaciers. Thus only 0.003% of the earth' total volume of water is easily available to us as soil moisture, groundwater, water vapor and water in lakes, streams, rivers and wetlands.


River, lakes,
ground water
1%(or less)
Polar ice
(2%)
Oceans
(97%)
Oceans
Polar ice
River, lakes,
ground water

Where is Earth's Water?



Credit: U.S. Geological Survey, Water Science School. https://www.usgs.gov/special-topic/water-science-school
Data source: Igor Shiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, Water in Crisis: A Guide to the World's Fresh Water Resources. (Numbers are rounded).

Physical characteristics of water

- Pure water is colorless, odourless and tasteless. It is clear and does not absorb light. If any change in colour, taste and odour is present, then it may indicate water pollution.
- The maximum acceptable level of colour for the drinking water is 15 TCU (True colour unit).
- If turbidity appears in the water, it may indicate water pollution.
- **Temperature**– Temperature is not directly used to evaluate whether water is drinkable or not. However, in natural water systems like lakes and rivers, the temperature is a significant physical factor that determines water quality.

PHYSICAL PROPERTIES OF WATER:

1. Water has a high specific heat.
2. Water in a pure state has a neutral pH. As a result, pure water is neither acidic nor basic. Water changes its pH when substances are dissolved in it.
3. Water conducts heat more easily than any liquid except mercury.
4. Water molecules exist in liquid form over an important range of temperature from 0 - 100° Celsius.
5. Water has a high surface tension.
6. Water is a universal solvent.

Chemical properties of water

- **pH** – pH of water is measured between 0 and 14 to determine how acidic or alkaline it is. Measurement is conducted using a logarithmic scale.
- **TDS** – If water is filtered to remove suspended solids, the remaining solid in the water indicates the total dissolved solids. If the total dissolved solids in the water exceed 300 mg/l, it adversely affects living organisms as well as industrial products.
- **Dissolved oxygen** – is the level of free, non-compound oxygen present in water. It is an essential parameter in assessing water quality because of its influence on the organisms living in water bodies.

ANALYSES OF PHYSICAL, CHEMICAL AND BIOLOGICAL PARAMETERS:

- **Physical parameters:** Colour, Odour, Temperature, Transparency and Turbidity.

- **Chemical parameters:** pH, Electrical Conductivity (E.C), Total Solids (TS), Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Total Hardness, Calcium Hardness, Magnesium Hardness, Nitrates, Phosphates, Sulphates, Chlorides, Dissolved Oxygen (D.O), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Fluorides, Free Carbon-di-oxide, Potassium and Sodium.

- **Heavy metals:** Lead, Copper, Nickel, Iron, Chromium, Cadmium and Zinc.

- **Biological parameters:** The biological parameters involved the qualitative analyses of planktons (zooplankton and phytoplankton) i.e. coliforms.

Types of water

Hard water

- Reacts with soap to form a scum so you need **more** soap to form a lather.
- Contains dissolved compounds of calcium and magnesium from **rocks**.
- These compounds have dissolved as water meets rocks.
- There are 2 types of hard water; permanent and temporary.

Soft water

- Soap forms a lather readily.
- Not as "good" for you as NO calcium present which is good for bones and teeth.
- Cheaper than hard water because
  - less soap is needed.
  - No limescale to damage appliances. (unlike temporary hard water)

WATER POLLUTION

- ✔ When the quality or composition of water changes directly or indirectly as a result of human activities such that it becomes unfit for any purpose it is said to be polluted.
- ✔ **The World Health Organisation (WHO) says that polluted water is water whose composition has been changed to the extent that it is unusable.**
- ✔ In other words, it is toxic water that cannot be drunk or used for essential purposes like agriculture, and which also causes diseases like diarrhoea, cholera, dysentery, typhoid and poliomyelitis that kill more than 500,000 people worldwide every year.

- ✔ **The main water pollutants include bacteria, viruses, parasites, fertilisers, pesticides, pharmaceutical products, nitrates, phosphates,** plastics**, faecal waste and even radioactive substances.**
- ✔ These substances do not always change the colour of the water, they are often invisible pollutants.

Types of Water pollution

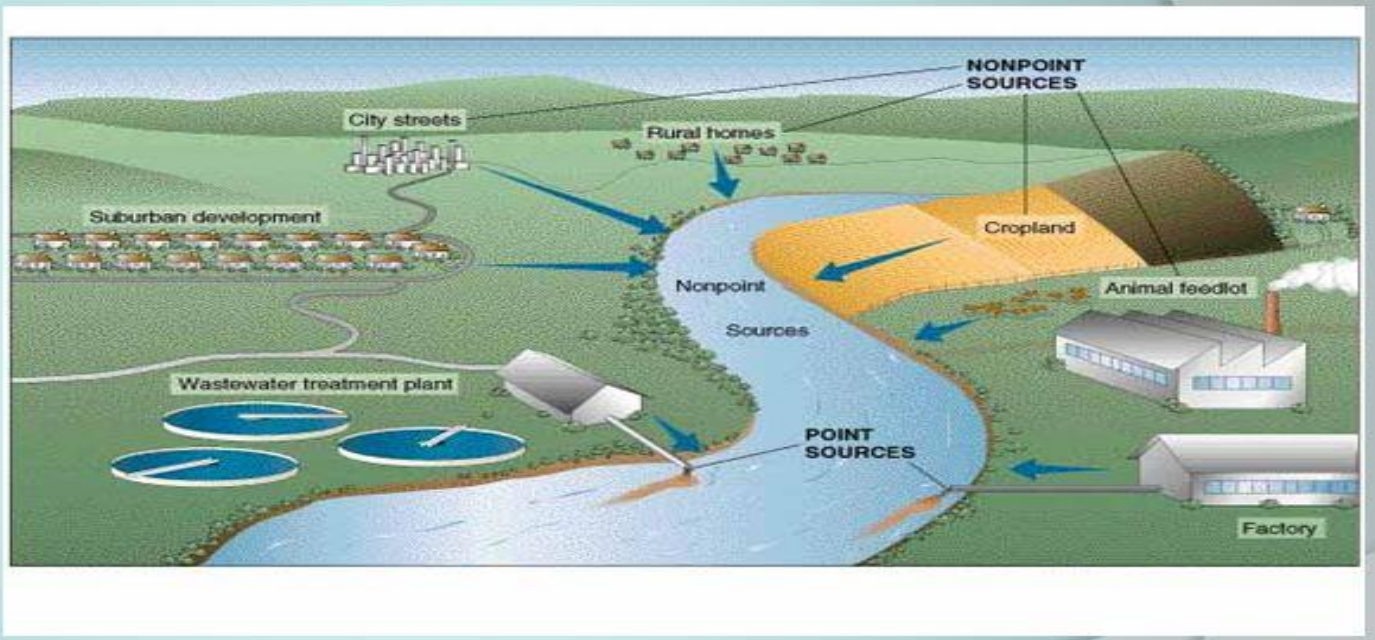
Point sources of pollution: When a source of pollution can be readily identified because it has a definite source and place where it enters the water it is said to come from a **point source.** Eg. Municipal and Industrial Discharge Pipes.

Non-point sources: When a source of pollution cannot be readily identified, such as agricultural runoff, acid rain, etc, they are said to be **non-point sources (diffused sources)** of pollution.

Water Pollutants: sources

a. Non-pont-source pollutants: agricultural runoff, storm-water drainage, atmospheric deposition.

b. Point-source pollutants: discharges from factories, sewage systems, power plants, underground coal mines, oil wells.

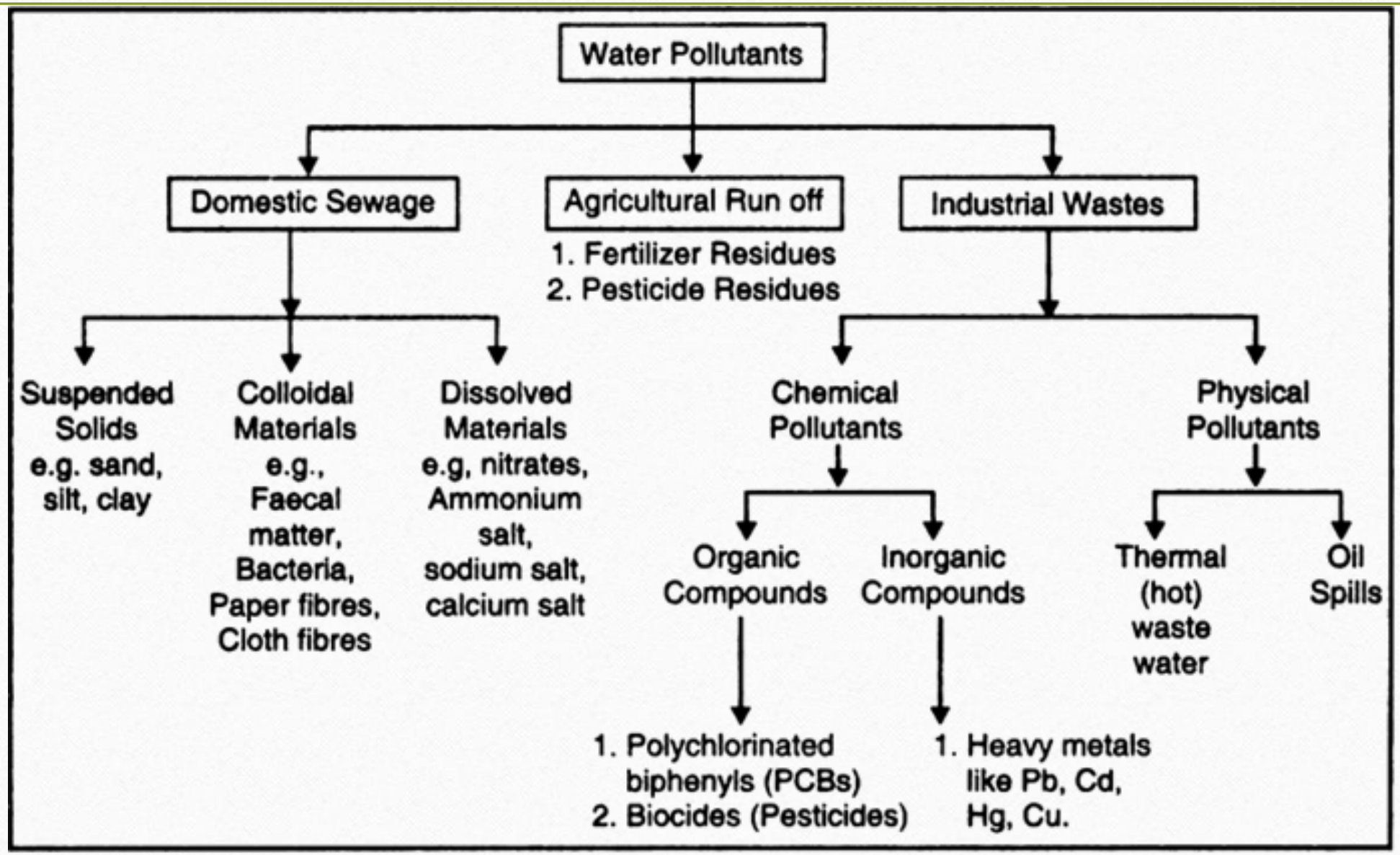


Sources of Water pollution

- The **disease-causing agents** (pathogens) which include bacteria, viruses, protozoa and parasitic worms that enter water from domestic sewage and untreated human and animal wastes.
- **Oxygen depleting wastes** are organic wastes that can be decomposed by aerobic (oxygen requiring) bacteria. Large populations of bacteria use up the oxygen present in water to degrade these wastes. In the process this degrades water quality.
- **Inorganic plant nutrients** are water soluble nitrates and phosphates that cause excessive growth of algae and other aquatic plants. The excessive growth of algae and aquatic plants due to added nutrients is called eutrophication.

- **Water soluble inorganic chemicals** which are acids, salts and compounds of toxic metals such as mercury and lead. High levels of these chemicals can make the water unfit to drink, harm fish and other aquatic life, reduce crop yields and accelerate corrosion of equipment that use this water.
- Variety of **organic chemicals**, which include oil, gasoline, plastics, pesticides, cleaning solvents, detergent and many other chemicals. These are harmful to aquatic life and human health. They get into the water directly from industrial activity either from improper handling of the chemicals in industries and more often from improper and illegal disposal of chemical wastes.
- **Sediment of suspended matter** is another class of water pollutants. These are insoluble particles of soil and other solids that become suspended in water. This occurs when soil is eroded from the land.

- **Water soluble radioactive isotopes** can be concentrated in various tissues and organs as they pass through food chains and food webs. Ionizing radiation emitted by such isotopes can cause birth defects, cancer and genetic damage.
- **Hot water** let out by power plants and industries that use large volumes of water to cool the plant result in rise in temperature of the local water bodies. Thermal pollution occurs when industry returns the heated water to a water source.
- **Oil** is washed into surface water in runoff from roads and parking lots which also pollutes groundwater. Accidental oil spills from large transport tankers at sea have been causing significant environmental damage.


Water Pollutants
Domestic Sewage
Agricultural Run off
Industrial Wastes
1. Fertilizer Residues
2. Pesticide Residues
Suspended Solids e.g. sand, silt, clay
Colloidal Materials e.g., Faecal matter, Bacteria, Paper fibres, Cloth fibres
Dissolved Materials e.g, nitrates, Ammonium salt, sodium salt, calcium salt
Chemical Pollutants
Physical Pollutants
Organic Compounds
Inorganic Compounds
Thermal (hot) waste water
Oil Spills
1. Polychlorinated biphenyls (PCBs)
2. Biocides (Pesticides)
1. Heavy metals like Pb, Cd, Hg, Cu.

Classification of Water pollutants and their detrimental effects

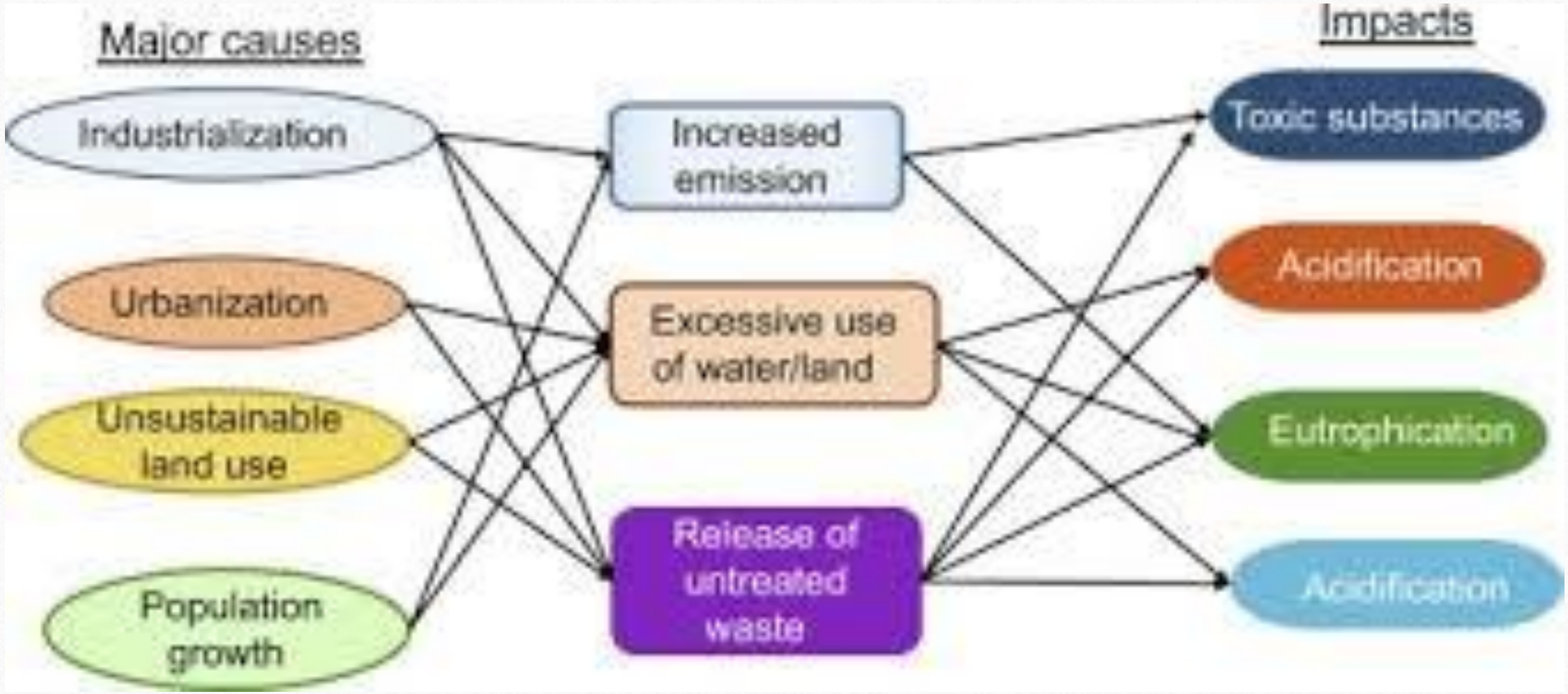
- The various types of water pollutants can be classified in to following major categories:
- 1) Organic pollutants, 2) Pathogens,
- 3) Nutrients and agriculture runoff, 4) Suspended solids and sediments,
- 5) Inorganic pollutants (salts and metals), 6) Thermal Pollutants
- 7) Radioactive pollutants.

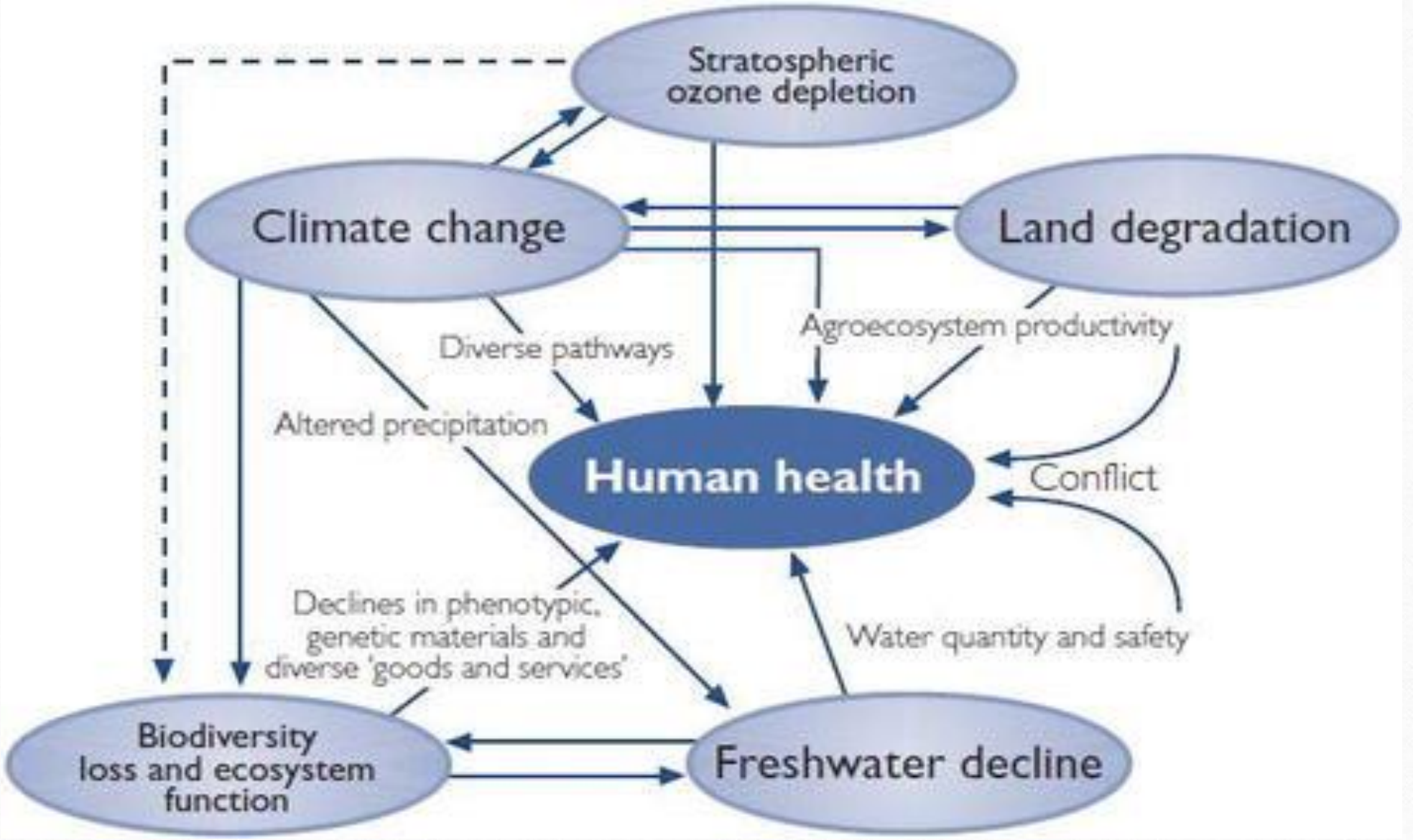
Classification of Water pollutants

Organic pollutants	• Natural organic pollutants, Sewage and industrial effluents • Synthetic organic contaminants, Microbiological pollutants, Oil
Inorganic pollutants	• Uranium, Radium • Radon and thorium
Radioactive pollutants	• Inorganic chemicals such as Al, B, Cd, Cr, Cu, F, Pb, Mn, Hg, Na etc. • Inorganic salts, mineral acids, trace elements, metals or metal compounds, organometallic compounds
Suspended solids and sediments	• Soil, sand and other solids • Disposal of sewage and industrial effluents
Heat	• Thermal pollution • Hot water from power plants and industries

Adverse effects of Water pollution

Physical effects	Suspended particle solids, oily surface of films
Oxidation effects	Oxidation by action of bacteria and chemical oxidation
Toxic chemical effects	Organic and inorganic chemical substances
Chemical nutrient effects	Nutrients such as nitrates and phosphates
Micro-organism effects	Pathogenic organisms such as bacteria , virus
Radionuclide effects	Nuclear waste
Eutrophication of lakes	Excessive growth of plants in a water body


Major causes
Industrialization
Urbanization
Unsustainable land use
Population growth
Increased emission
Excessive use of water/land
Release of untreated waste
Impacts
Toxic substances
Acidification
Eutrophication
Acidification


Stratospheric ozone depletion
Climate change
Land degradation
Diverse pathways
Agroecosystem productivity
Altered precipitation
Human health
Conflict
Declines in phenotypic, genetic materials and diverse 'goods and services'
Water quantity and safety
Biodiversity loss and ecosystem function
Freshwater decline

Effects of Water Pollution

- Lower DO may be harmful to animals.
- **Eutrophication**.
- **Bioaccumulation.**
- **Biomagnification**.
- Minimata disease, Blue **Baby Syndrome** or **Methaemoglobinemia and** Fluorosis
- Pesticides are harmful to **aquatic life**.
- Dyes and inorganic compounds induce colour change in animals

Control measures for preventing water pollution

1.Reduce, reuse & recycle.

2.Adopt Water Conservation Practices.

3.Proper dispose of medicated waste.

4.Avoid the Use of harmful chemicals like Pesticides and Herbicides.

5.Avoid Water-Polluting Recreational Activities.

6.Maintain your vehicles.

7.Afforestation or plantation.

8.Industrial waste water should be treatment before disposal.

Characterization of waste water (including DO, COD, BOD).

- Wastewater is the polluted form of water generated from rainwater runoff and human activities. It is also called sewage.
- It is typically categorized by the manner in which it is generated specifically as domestic sewage, industrial sewage, or storm sewage (storm water).

DISSOLVED OXYGEN

- Oxygen dissolved in water is a very important parameter in water analysis as it serves as an indicator of the physical, chemical and biological activities of the water body.
- The two main sources of dissolved oxygen are diffusion of oxygen from the air and photosynthetic activity.
- Diffusion of oxygen from the air into water depends on the solubility of oxygen, and is influenced by many other factors like water movement, temperature, salinity, etc.
- Photosynthesis, a biological phenomenon carried out by the autotrophs, depends on the plankton population, light condition, gases, etc.
- Oxygen is considered to be the major limiting factor in water bodies with organic materials.
- Dissolved oxygen is calculated by many methods.

Method 1: Membrane electrode method

Principle: The membrane electrode has a sensing element protected by an oxygen-permeable plastic membrane that serves as a diffusion barrier against impurities. Under steady conditions the electric current read is directly proportional to the D.O concentrations (electric current is directly proportional to the activity of molecular oxygen).

Apparatus required: Oxygen-sensitive membrane electrode and lab glassware.

Procedure: The calibrations are carried out following the manufacturer's calibration procedure. The electrode is dipped into the sample, and the reading noted.

Method 2: Winkler's method

Principle: Oxygen present in the sample oxidizes the dispersed divalent manganous hydroxide to the higher valency to precipitate as a brown hydrated oxide after addition of potassium iodide and sodium hydroxide. Upon acidification, manganese reverts to its divalent state and liberates iodine from potassium iodide, equivalent to the original dissolved oxygen content of the sample. The liberated iodine is titrated against N/80 sodium thiosulphate using fresh iodine as an indicator.

Apparatus required: BOD bottles-300ml capacity, sampling devices, lab glassware - measuring cylinder, conical flasks, etc., and Bunsen burner.

REAGENTS:

1. Manganese sulphate: 480g of manganous sulphate tetrahydrate is dissolved and made up to 1000ml with distilled water (Discarded if it changes colour with starch).
2. Alkaline iodide-azide reagent: 500g of sodium hydroxide and 150g of potassium iodide along with 10g of sodium azide (NaN3) is dissolved and made up to 1000ml with distilled water.
3. Conc. sulphuric acid
4. Starch indicator: 0.5g of starch is dissolved in distilled water and boiled for few minutes.
5. Stock sodium thiosulphate: 24.82g of sodium thiosulphate pentahydrate (Na2S202. 5H2O) is dissolved in distilled water and made up to 1000ml.
6. Standard sodium thiosulphate (0.025N): 250ml of the stock sodium thiosulphate pentahydrate is made up to 1000ml with distilled water to give 0.025N.

Procedure:

- The samples are collected in BOD bottles, to which 2ml of manganous sulphate and 2ml of potassium iodide are added and sealed.
- This is mixed well and the precipitate is allowed to settle down.
- At this stage 2ml of conc. sulphuric acid is added, and mixed well until all the precipitate dissolves.
- 203ml of the sample is measured into the conical flask and titrated against 0.025N sodium thiosulphate using starch as an indicator.
- The end point is the change of colour from blue to colourless.

Calculations:

1ml of 0.025N Sodium thiosulphate = 0.2mg of Oxygen

$$\text{Dissolved Oxygen(as mg/L)} = \frac{(0.2)\,(1000 \text{ ml of Sodium thiosulphate})}{200}$$

COD- Chemical Oxygen Demand

- ✔ The chemical oxygen demand (**COD**) is a measure of water and wastewater quality.
- ✔ The **COD** test is often used to monitor **water** treatment plant efficiency.
- ✔ The **COD** is the amount of oxygen consumed to chemically oxidize organic water contaminants to inorganic end products.
- ✔ Higher **COD** levels mean a greater amount of oxidizable organic material in the sample, which will reduce dissolved oxygen (**DO**) levels.
- ✔ A reduction in **DO** can lead to anaerobic conditions, which is deleterious to higher aquatic life forms.
- ✔ **High COD** levels in water runoff are **due to** residual food and beverage waste, emulsified oils from food processing industries and agricultural activities.

BOD- Biological Oxygen Demand

- ✔ BOD is a measure of the amount of oxygen required to remove waste organic matter from water in the process of decomposition by aerobic bacteria.
- ✔ BOD is used in waste water treatment plants as an index of the degree of organic pollution.
- ✔ The amount of oxygen required to completely oxidize the organic compounds to carbon dioxide and **water** by micro organism.
- ✔ Higher BOD indicates more oxygen is required, which is less for oxygen-demanding species to feed on, and signifies lower water quality.
- ✔ Inversely, low BOD means less oxygen is being removed from water, so water is generally purer.

BOD Level in mg/liter	Water Quality
1 - 2	**Very Good:** There will not be much organic matter present in the water supply.
3 - 5	**Fair:** Moderately Clean
6 - 9	**Poor:** Somewhat Polluted - Usually indicates that organic matter present and microorganisms are decomposing that waste.
100 or more	**Very Poor:** Very Polluted - Contains organic matter.

DIFFERENCES BETWEEN BOD & COD

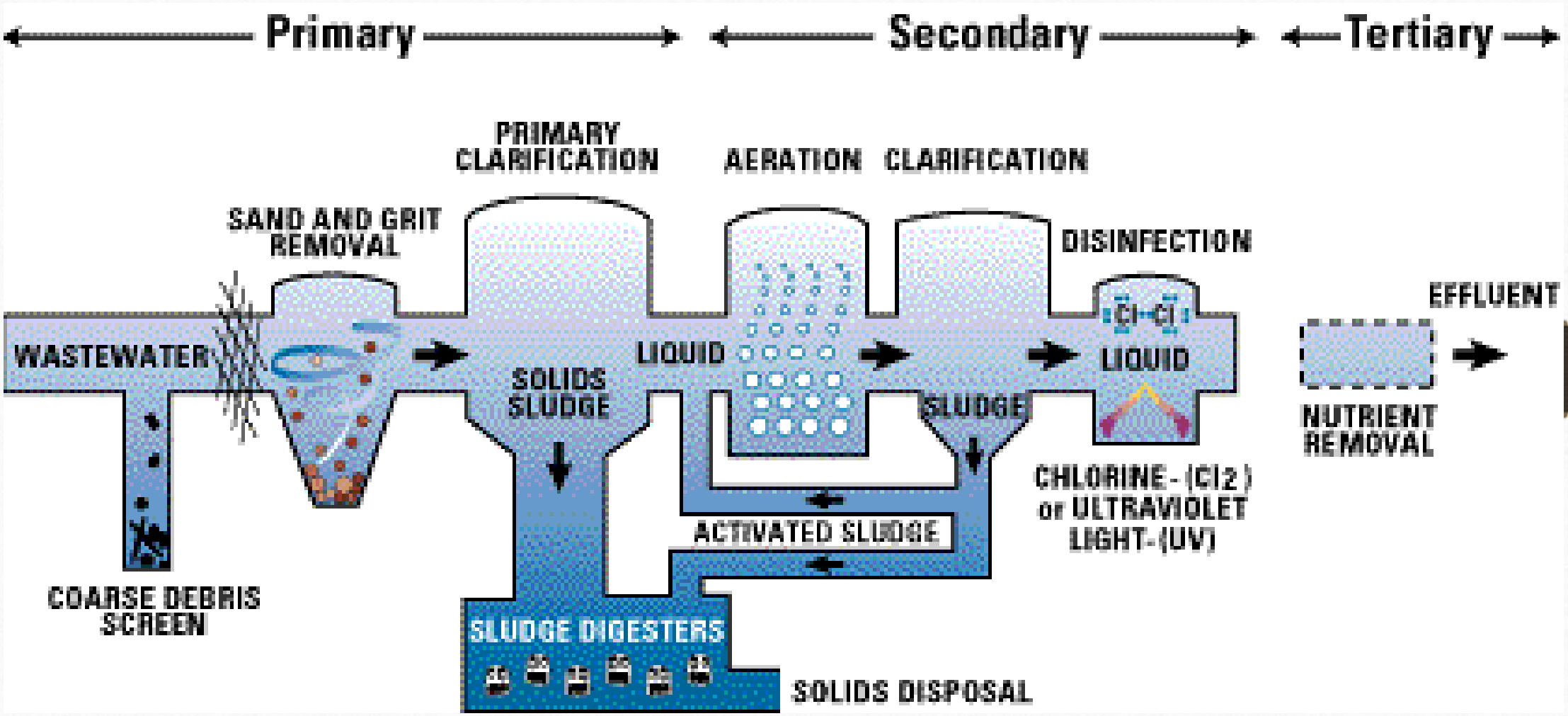
BOD	COD
Measures biodegradable organics	Measures biodegradable and non biodegradable organics
Uses oxidizing microorganism	Uses a strong chemical agent
Affected by toxic substance	Not affected
Affected by temperature	Not affected
5 days incubation	2.5 hrs
Accuracy ± 10%	Accuracy ± 2%

Waste water treatment

- Preliminary Treatment
- Primary Treatment
- Secondary / Biological Treatment
- Tertiary / Final Treatment

Classification of Treatment processes

Preliminary treatment	• **Physical:** Sedimentation • Screening • Aeration• Particles Filtration (≥ 1µm) • Flotation and skimming • Degasification • Equalization
Primary treatment	• **Chemical:** Chlorination • Ozonation • Neutralization • Coagulation • Adsorption • Ion exchange
Secondary treatment	• **Biological:** aerobic: •activated sludge treatment methods • trickling filtration• oxidation ponds • lagoons • aerobic digestion • anaerobic: •anaerobic digestion • septic tanks • lagoons
Tertiary treatment	• **Final treatment:** Disinfection • oxidation • chemical dosing for water quality correction • chemically aided settling • filtration • softening • activated carbon treatment • ion exchange • membrane processes


Primary
Secondary
Tertiary
PRIMARY CLARIFICATION
AERATION
CLARIFICATION
SAND AND GRIT REMOVAL
DISINFECTION
EFFLUENT
WASTEWATER
SOLIDS SLUDGE
LIQUID
SLUDGE
LIQUID
NUTRIENT REMOVAL
CHLORINE - (Cl2) or ULTRAVIOLET LIGHT - (UV)
ACTIVATED SLUDGE
COARSE DEBRIS SCREEN
SLUDGE DIGESTERS
SOLIDS DISPOSAL

Preliminary Treatment

Screening	• First step of sewage treatment • Screen may be of uniform size, parallel bars or rods, gratings, perforation, filters etc.
Grit Chamber	• It is a channels to remove the heavier inorganic materials. • It works along the gravity and velocity.
Detritus Chamber	• These are continuous flow settling tanks, where both grit and fine sand particles are removed.
Skimming Tanks	• It helps in the removal of grease, oil & waxy materials. • The amount of greasy and oily material removal depends upon the place.

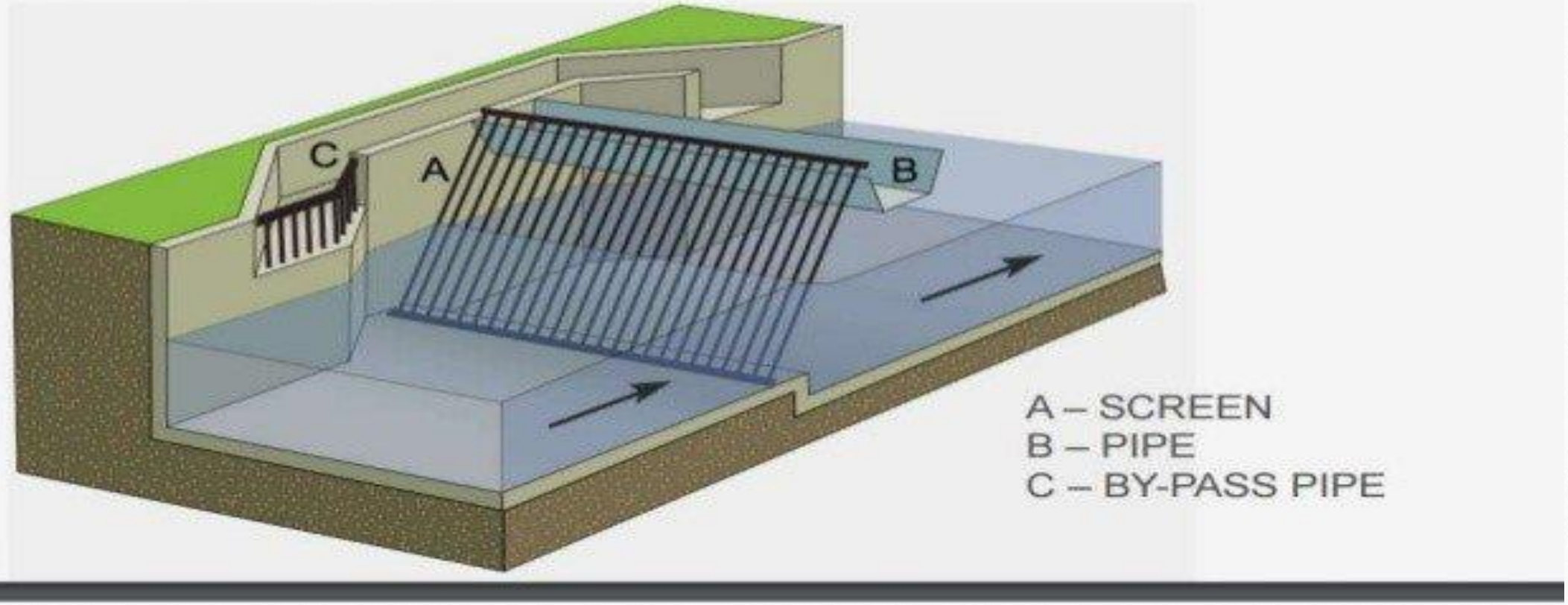
- Screening: The removal of floatable or suspended coarse solids in raw wastewater, which includes rags, paper, plastic, rubber, and vegetable matter (Clay et al., 1996). Bar screens are the most commonly used screening devices, with a typical spacing between bars of 15 to 25 mm (Mara, 2003). Bar screens are cleaned manually in small wastewater treatment plants and mechanically in large ones.

- Grit removal: The gravity separation of heavy small solids with a specific gravity greater than putrescible organic matter (e.g., sand, gravel, coffee grounds). Grit is removed in grit chambers, which can be operated manually in small plants or be mechanized in larger plants.

Screenings and grit, if not removed at the beginning of a wastewater treatment plant, can impair downstream treatment processes and damage equipment (e.g., pumps) (Metcalf and Eddy/AECOM, 2014). Figure 1 shows where preliminary treatment is used within the sanitation service chain. Figures 2 through 5 show examples of manual and mechanized preliminary treatment systems in operation.

Screening

Bar screens

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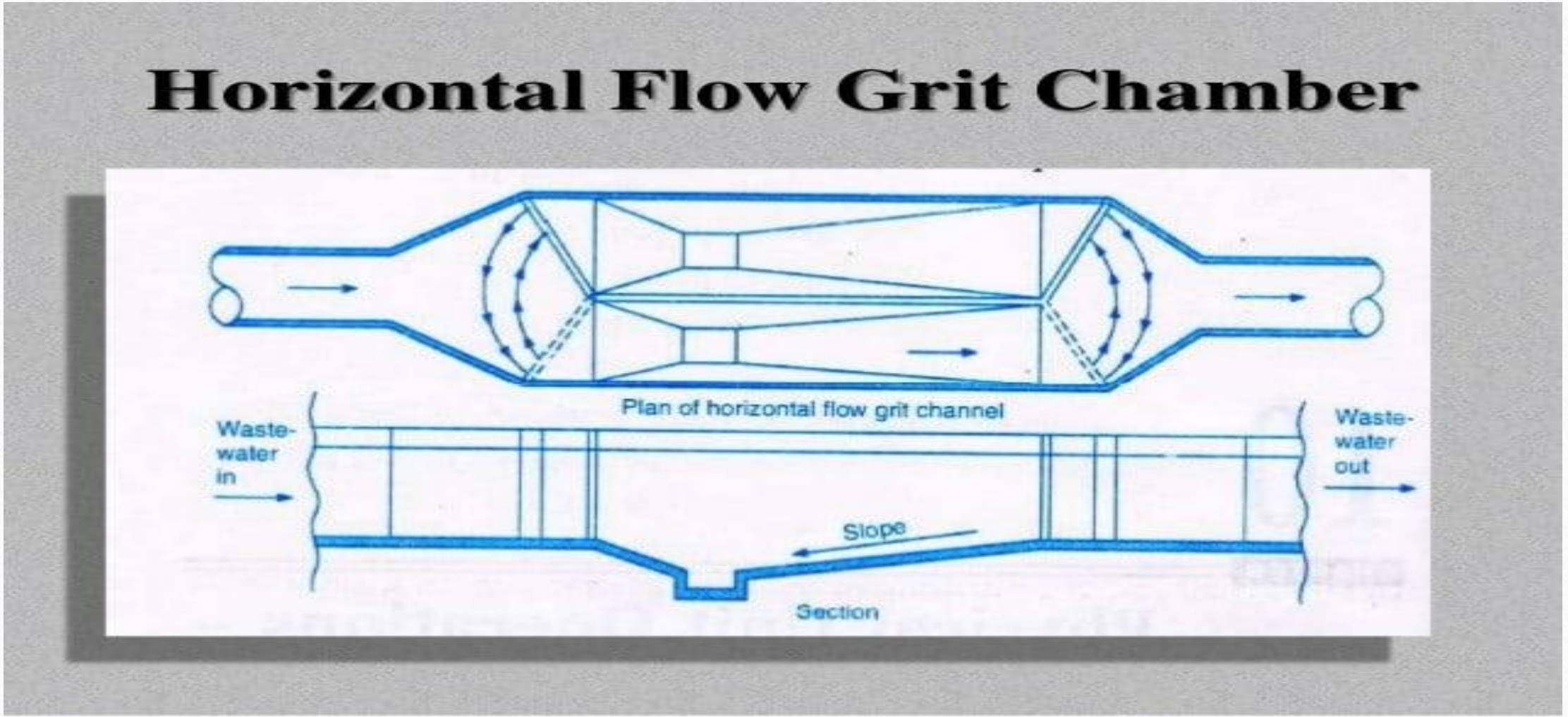
Grit Chamber

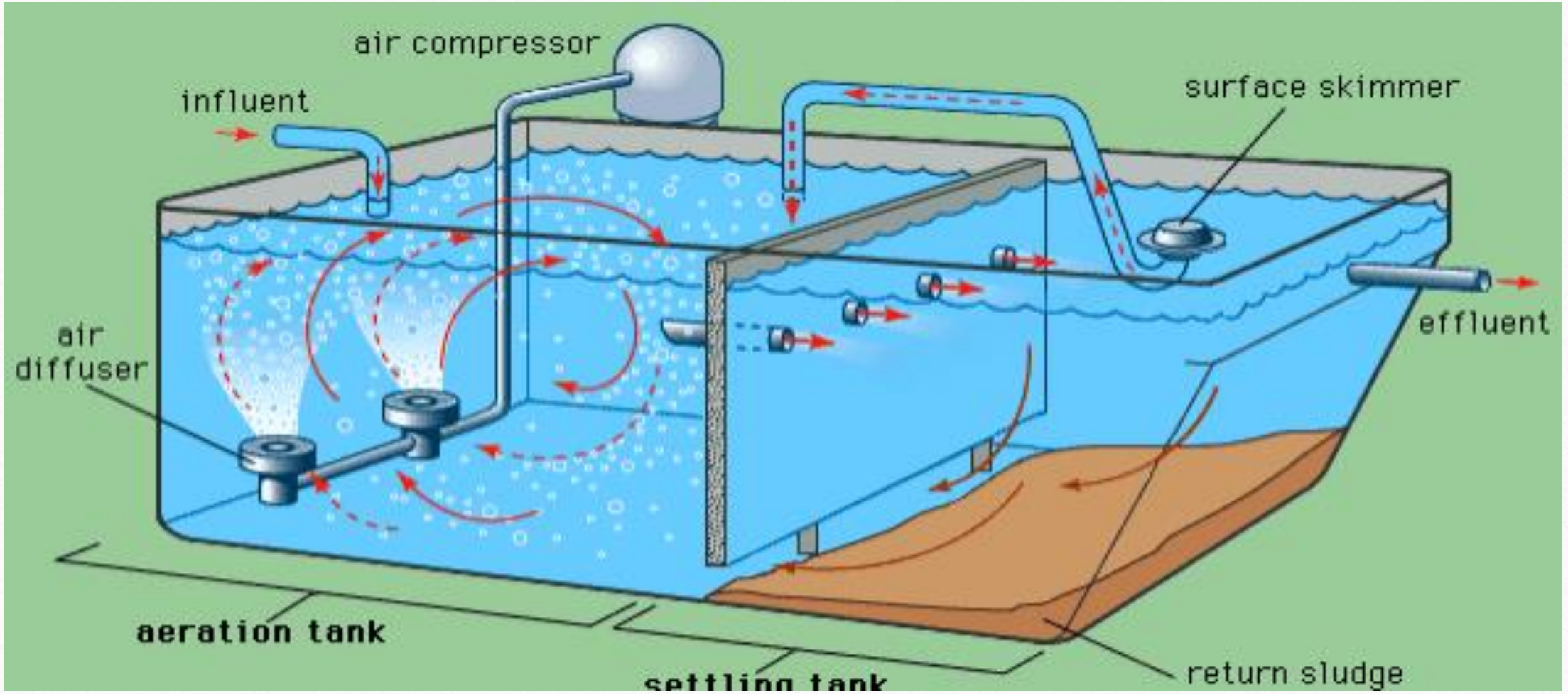
- ✔ Grit Chamber comes after Screen or Equalization and Neutralization tank Depending upon the design of wastewater treatment plant.
- ✔ Grit Chambers, also known as grit channels, are sedimentation basins that are normally located after the fine screens and, in most cases, before the primary sedimentation tank.
- ✔ The grit chamber removes inorganic grit with a diameter size of 0.15 to 0.20 mm or greater, such as sand, gravel, and other mineral matter.
- ✔ Grit includes non-putrescible organic stuff like rags, coffee grounds, vegetable cuttings, ash clinker, wood fragments, and tea leaves, as well as tiny mineral particles that may settle.
- ✔ In general, grit removal channels are designed to remove all particles with a specific gravity of 2.65 or higher, a diameter size of 0.20 mm or more, and a settling velocity of about 0.02 m/s (at 10°C); however, some grit removal channels are designed to remove particles larger than 0.15 mm, with a settling velocity of about 0.015 m/s (at 10°C).

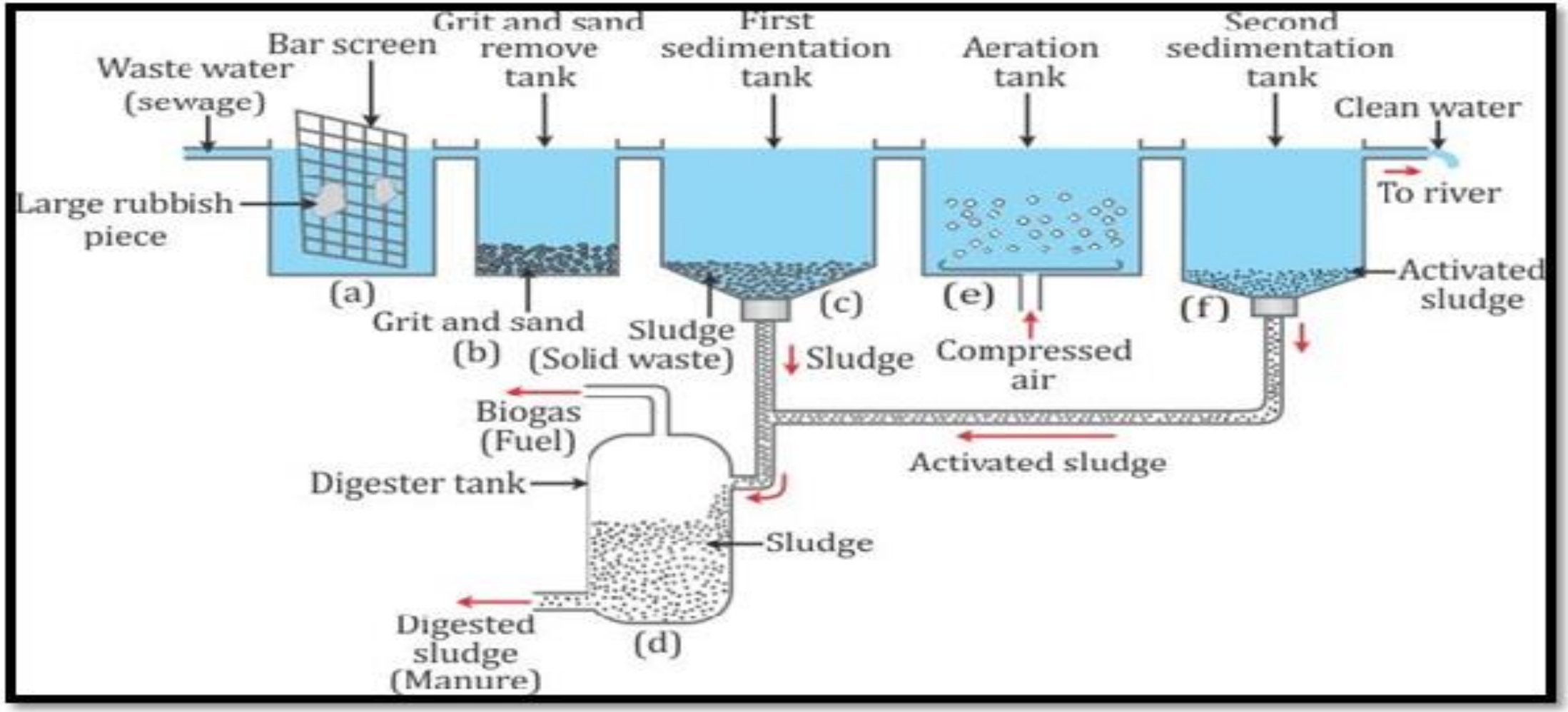
Grit Chamber

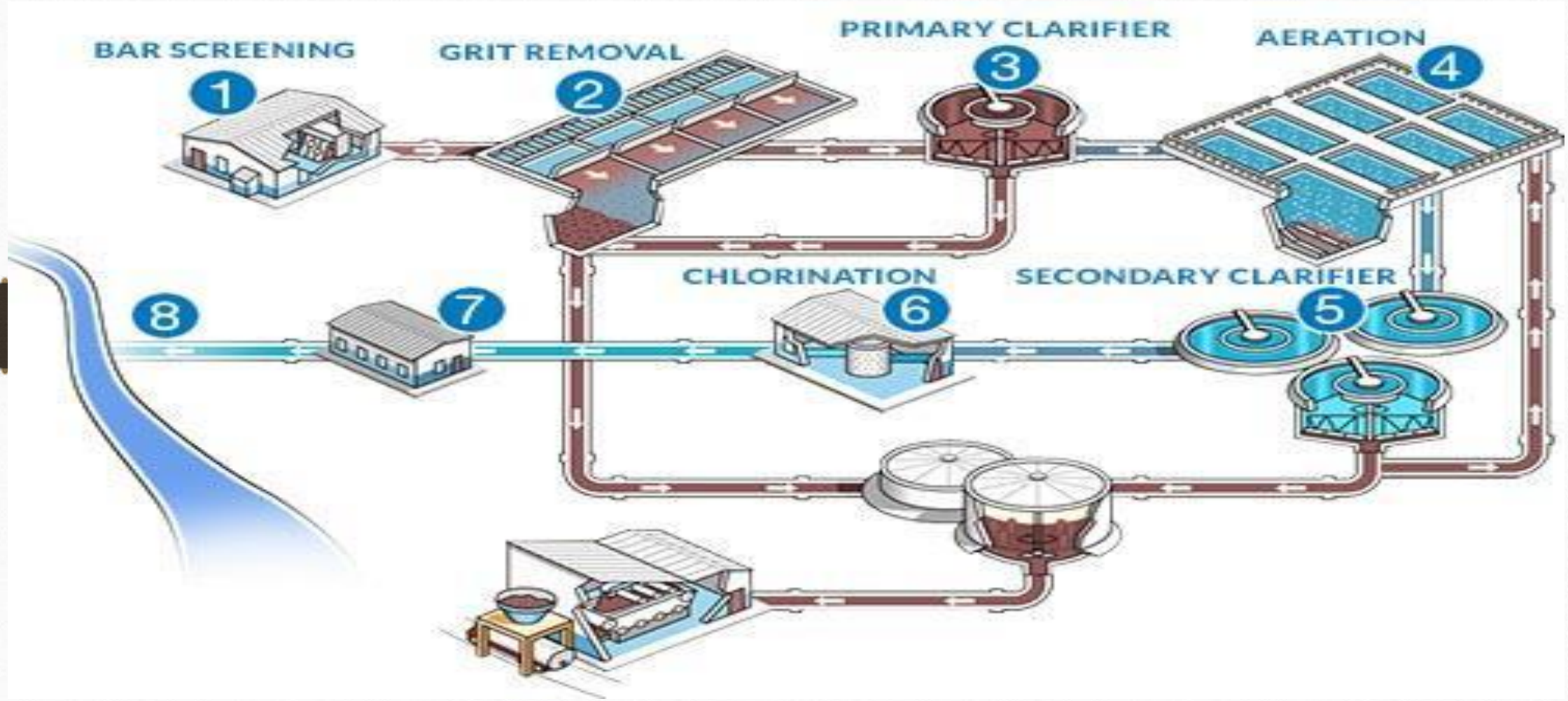


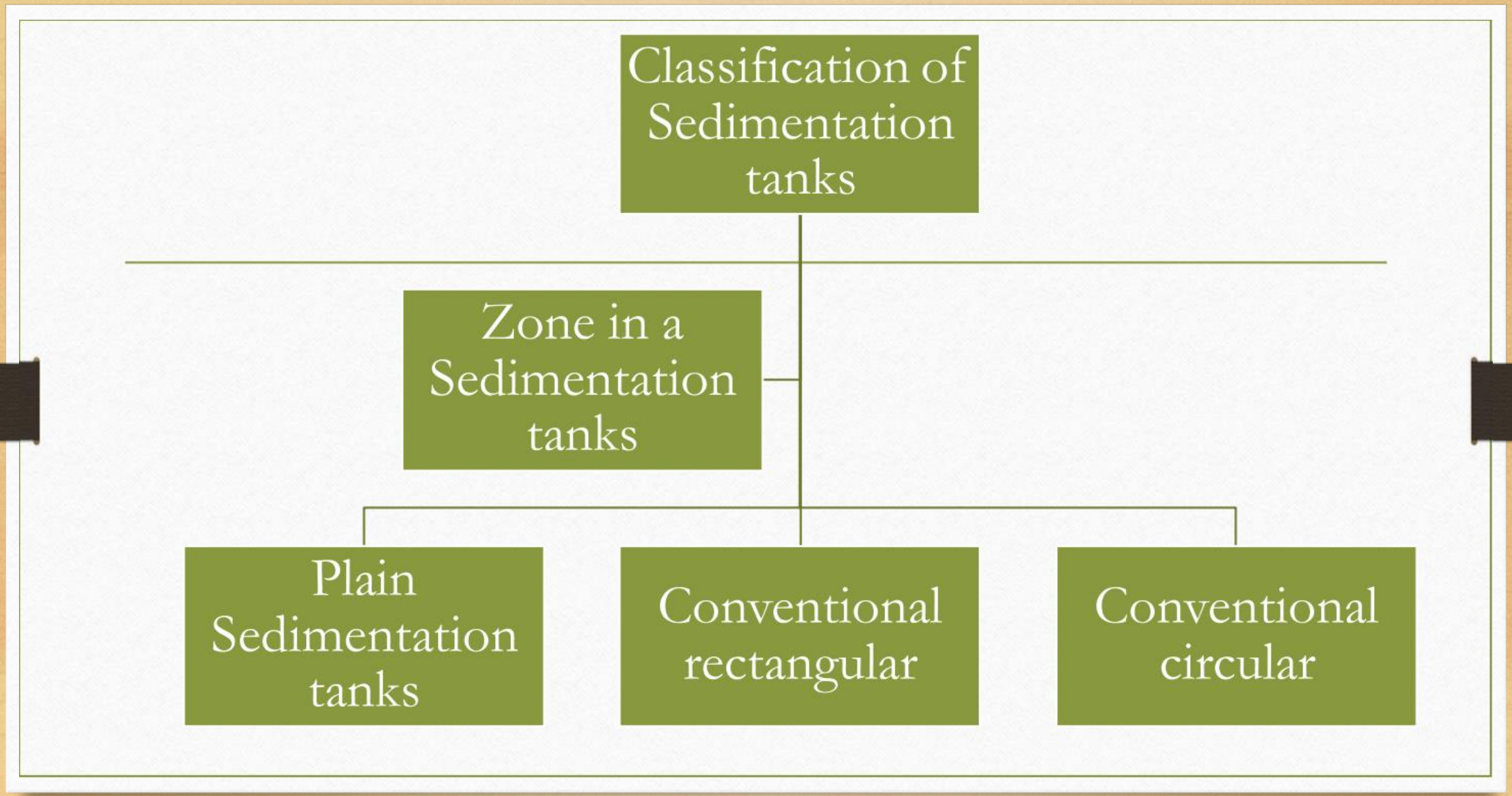
Advantages of Grit chamber

- ✔ To protect pump and other equipment
- ✔ To avoid overloading of treatment
- ✔ To reduce the cleaning frequency of sedimentation tank
- ✔ To reduce clogging of pipe

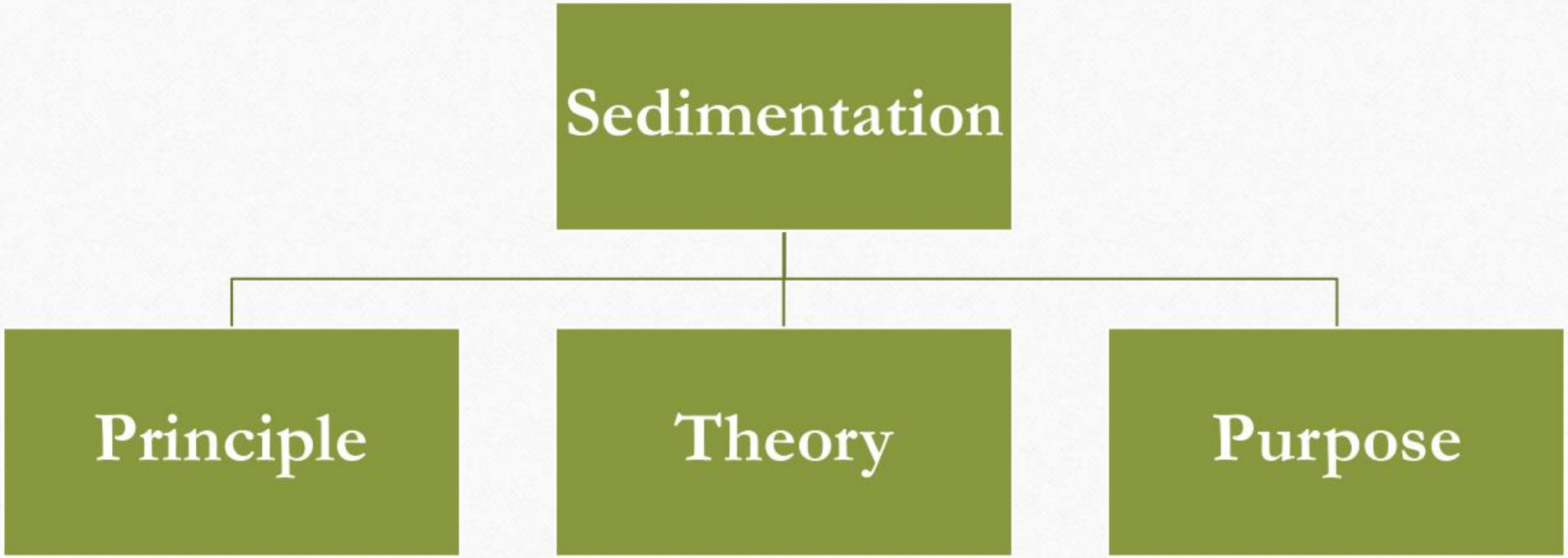

air compressor
influent
surface skimmer
air
diffuser
effluent
aeration tank
settling tank
return sludge


Waste water
(sewage)
Bar screen
Grit and sand
remove
tank
First
sedimentation
tank
Aeration
tank
Second
sedimentation
tank
Clean water
To river
Large rubbish
piece
(a)
Grit and sand
(b)
Sludge
(Solid waste)
(c)
Sludge
(e)
Compressed
air
(f)
Activated
sludge
Biogas
(Fuel)
Digester tank
Activated sludge
Sludge
Digested
sludge
(Manure)
(d)


BAR SCREENING
1
GRIT REMOVAL
2
PRIMARY CLARIFIER
3
AERATION
4
SECONDARY CLARIFIER
5
CHLORINATION
6
7
8


Classification of Sedimentation tanks
Zone in a Sedimentation tanks
Plain Sedimentation tanks
Conventional rectangular
Conventional circular

Methods and Equipment used in wastewater treatment- Primary



Primary Treatment

Sedimentation

- The residual waste after screening, grit & skimming process is removed through sedimentation.
- Sedimentation with biological treatment is known as secondary treatment.

Principle

- The specific gravity of solid present in sewage is greater than that of water.
- Therefore, in still sewage, these solids particles will tend to settle down by gravity, where as they will remain in suspension in a flowing sewage due to turbulence.
- Hence these particles will settle down as soon as the turbulence is retarded by the offering storage to the sewage.

- ✔ A sedimentation tank is structure in which wastewater is filled and stored for some time to remove the suspended particles present in the water.
- ✔ These particles may settle at the bottom of the tank and are removed by using scrapers. If the suspended particles have low specific gravity than water, they settle at the top of the tank.

Purpose of sedimentation

- ✔ To remove organic solids (helps in preventing BOD).
- ✔ To avoid the formation of sludge banks, when sewage is to be discharged into the water bodies.
- ✔ To prevent excessive organic loading & clogging of soil pores, where land disposal of sewage is practiced.
- ✔ To reduce load on secondary treatment units.

Zones in a sedimentation Tank

Inlet zone	• This zone decreases the velocity of influent and distributes the flow evenly across the tank.
Settling zone	• This provides a calm area free from interference, for the suspended materials to settle down.
Outlet zone	• This zone provides a smooth and uniform exit of the effluent from the settling zone.
Sludge zone	• This zone receives the settled solids & prevents their resuspension.

Secondary/Biological treatment

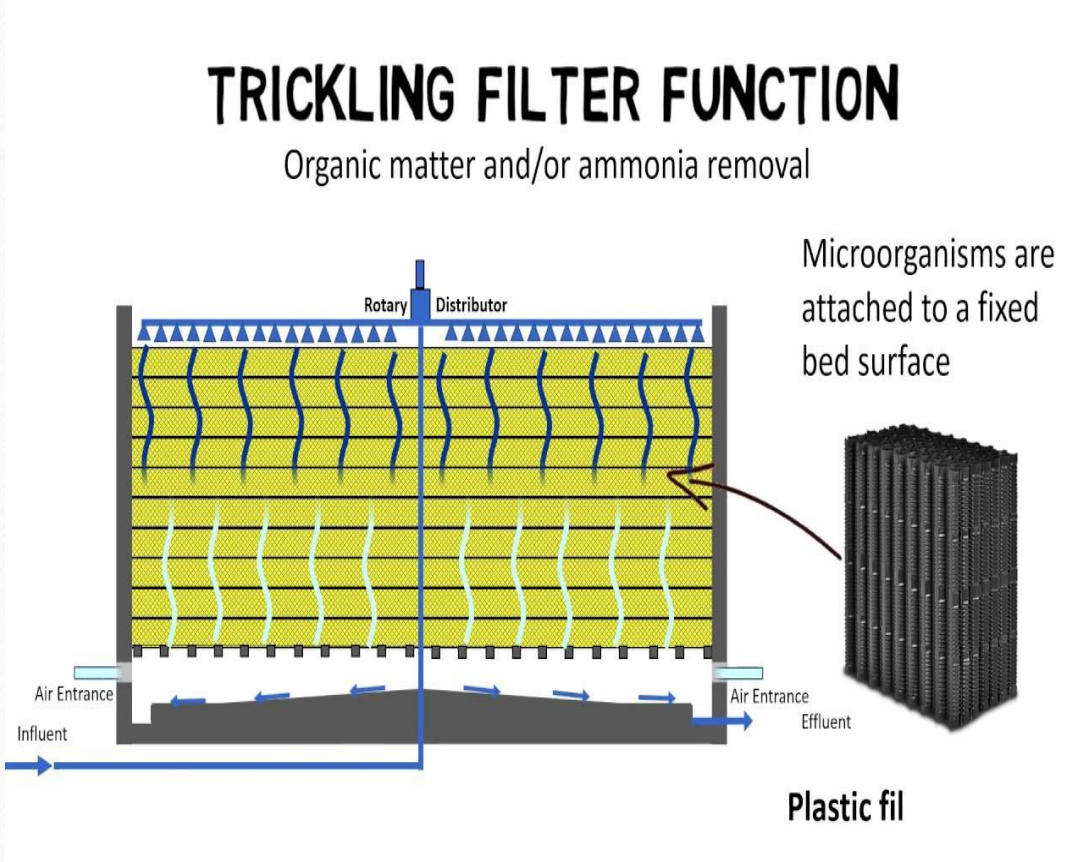
- ✔ It is carried out for the removal of fine suspended & dissolved organic matter present in the effluent from the primary treatment unit, by means of biological flocculation or precipitation.
- ✔ Here bacteria and other micro-organisms decomposes the unstable organic matter.

Trickling Filters

- ✔ A **trickling filter** is a type of wastewater secondary treatment system.
- ✔ It consists of a fixed bed of rocks, coke, gravel, slag, polyurethane foam, sphagnum peat moss, ceramic, or plastic media over which sewage or other wastewater flows downward and causes a layer of microbial slime (biofilm) to grow, covering the bed of media.
- ✔ **Trickling filters** (TFs) are used to remove organic matter from wastewater. The TF is an aerobic treatment system that utilizes microorganisms attached to a medium to remove organic matter from wastewater.

- ✔ In contrast, systems in which microorganisms are sustained in a liquid are known as suspended-growth processes.
- ✔ conditions are maintained by splashing, diffusion, and either by [forced-air] flowing through the bed or natural convection of air if the filter medium is porous.
- ✔ The terms 'trickle filter', 'trickling biofilter', 'biofilter', 'biological filter' and 'biological trickling filter' are often used to refer to a 'trickling filter'.
- ✔ These systems have also been described as roughing filters, intermittent filters, packed media bed filters, alternative septic systems, percolating filters, attached growth processes, and fixed film processes.

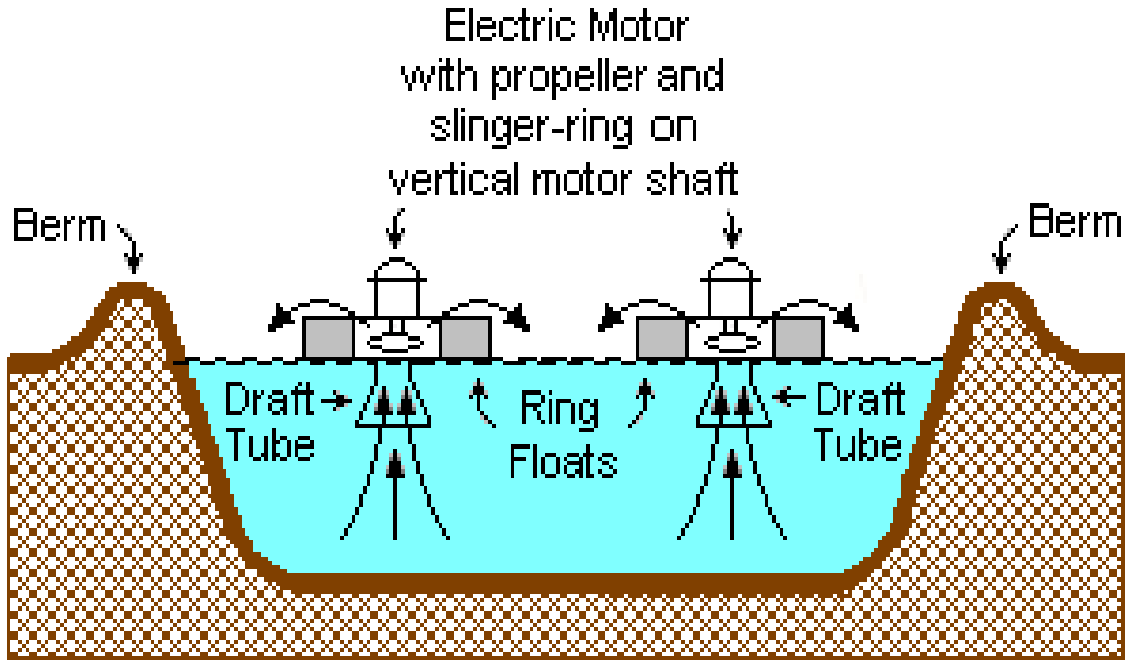
Advantages of Trickling filters



- ✔ Effluents obtained are nitrified & stable.
- ✔ It helps in the removal of 80% BOD.
- ✔ It is a simple process does not require any skill.
- ✔ Mechanical wear & tear is less, also equipments are less.
- ✔ So it requires less electricity for operation.

Aerated Lagoon Plant

An aerated pond or **aerated lagoon** is a simple wastewater treatment system consisting of a pond with artificial **aeration** to promote the biological oxidation of wastewaters.



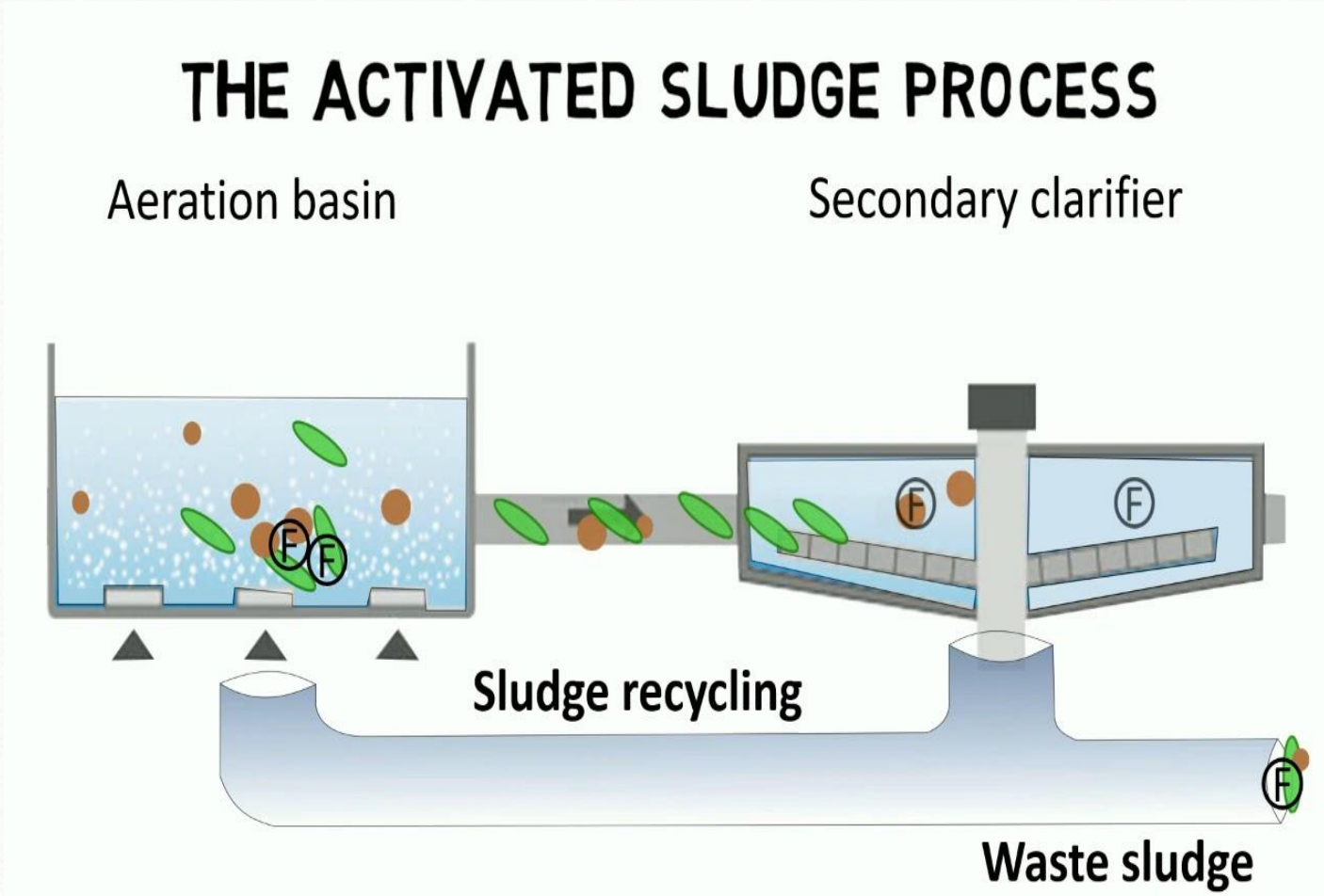
A TYPICAL SURFACE – AERATED BASIN

- ✔ An **aerated lagoon** (or **aerated pond**) is a simple wastewater treatment system consisting of a **pond** with artificial **aeration** to promote the biological oxidation of wastewaters.
- ✔ They all have in common the use of oxygen (or air) and microbial action to reduce the pollutants in wastewaters.
- ✔ **Aeration** brings water and air in close contact in order to remove dissolved gases (such as carbon dioxide) and oxidizes dissolved metals such as iron, hydrogen sulfide, and volatile organic chemicals (VOCs).
- ✔ **Aeration** is often the first major **process** at the treatment plant.

- ✔ They are again cost effective simple process.
- ✔ But lagoon system requires more land and they are less effective in colder climatic conditions.
- ✔ Lagoons also provide breeding area for mosquitoes and flies.

Activated Sludge Process

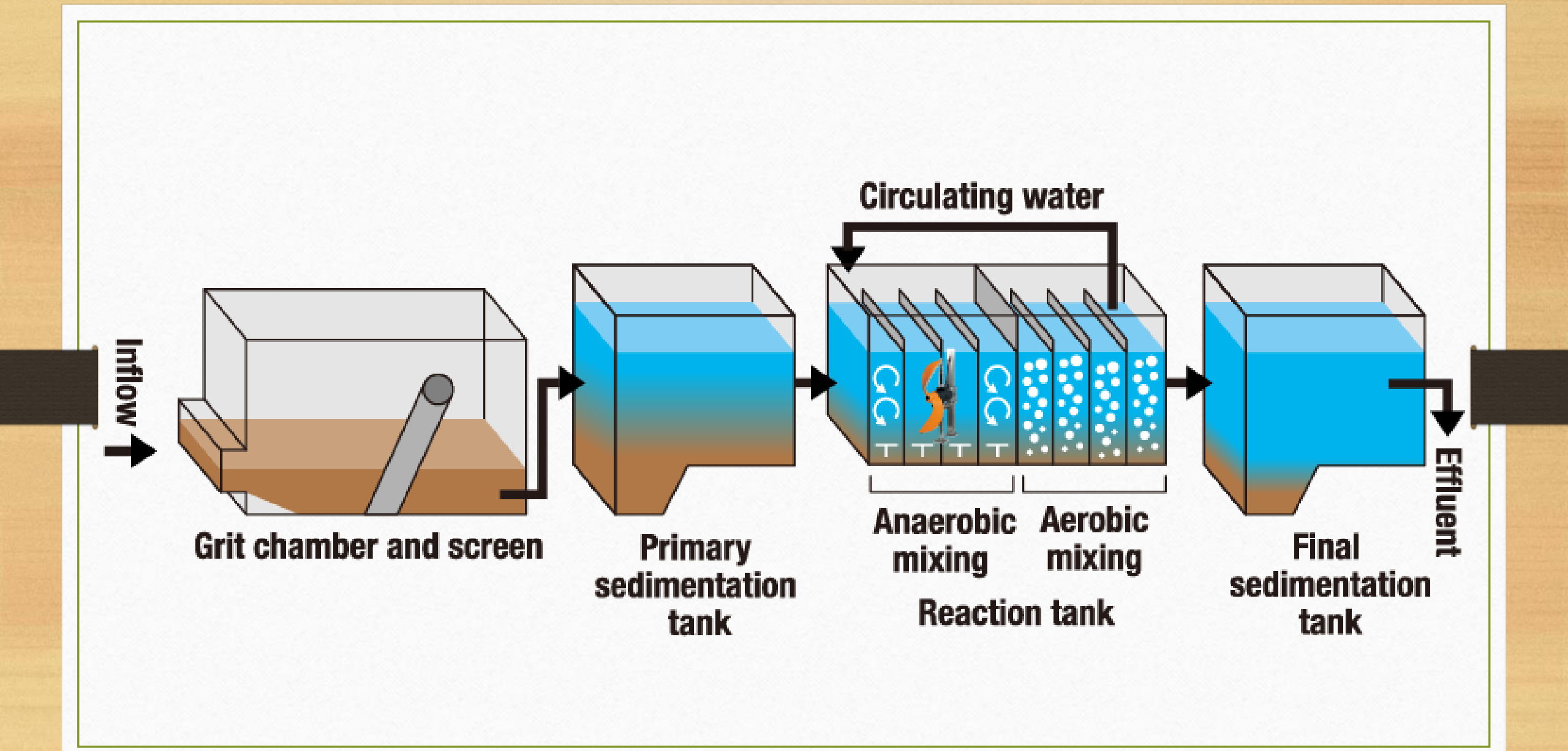
The **activated sludge process** is a type of wastewater **treatment process** for treating sewage or industrial wastewaters using aeration and a biological floc composed of bacteria and protozoa.

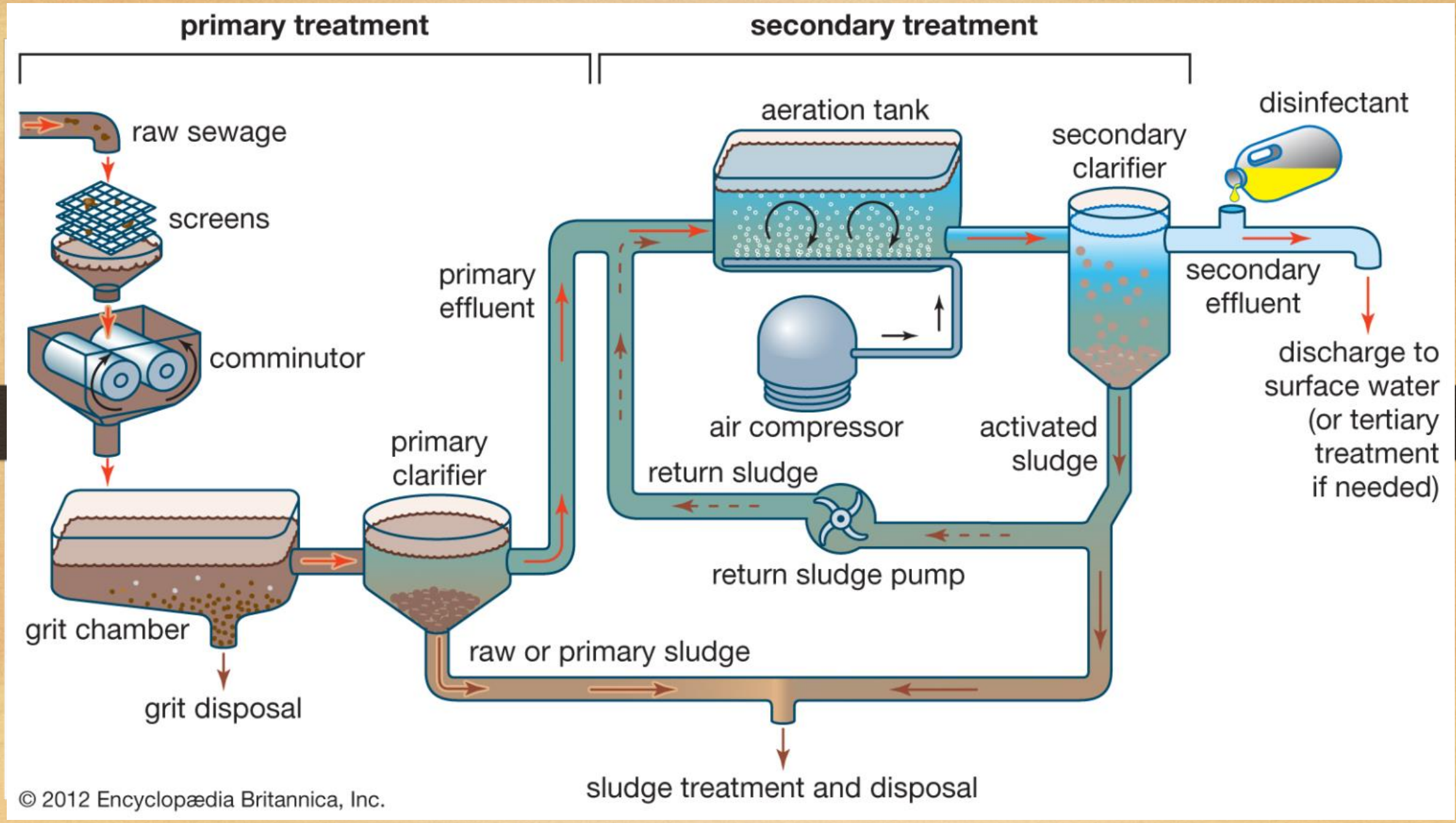


- ✔ The **activated sludge process** is an integral **process** used to treat wastewater.
- ✔ Air or oxygen is blown into raw sewage. The **process** oxidizes organic matters in the wastewater, producing new cells, carbon dioxide, and water.
- ✔ The **sludge** particles can then be removed through the **process** of gravity settling.
- ✔ The **activated sludge** is the most widely **used** method to bring about stabilization in wastewater having organic matter constituents.

Tertiary Waste water Treatment

- ✔ **Tertiary treatment** is the final cleaning process that improves **wastewater** quality before it is reused, recycled or discharged to the environment. The **treatment** removes remaining inorganic compounds, and substances, such as the nitrogen and phosphorus.
- ✔ **Tertiary systems** carry the same treatment process as a secondary **system** with an additional filtration or "polishing" process often in the form of UV treatment. This process will further remove the remaining organic matter and bacteria. **Tertiary systems** are required in very sensitive receiving environments.


Circulating water
Inflow
Grit chamber and screen
Primary sedimentation tank
Anaerobic mixing
Aerobic mixing
Reaction tank
Final sedimentation tank
Effluent


primary treatment
secondary treatment
raw sewage
screens
comminutor
grit chamber
grit disposal
primary clarifier
primary effluent
aeration tank
air compressor
return sludge
return sludge pump
raw or primary sludge
sludge treatment and disposal
activated sludge
secondary clarifier
disinfectant
secondary effluent
discharge to surface water (or tertiary treatment if needed)
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Measures to control water pollution

- ✔ Developing proper sewage system
- ✔ Waste water treatment
- ✔ Shifting from industrial agriculture to organic farming
- ✔ Conservation of natural water resources
- ✔ Extensive afforestation
- ✔ Public awareness.