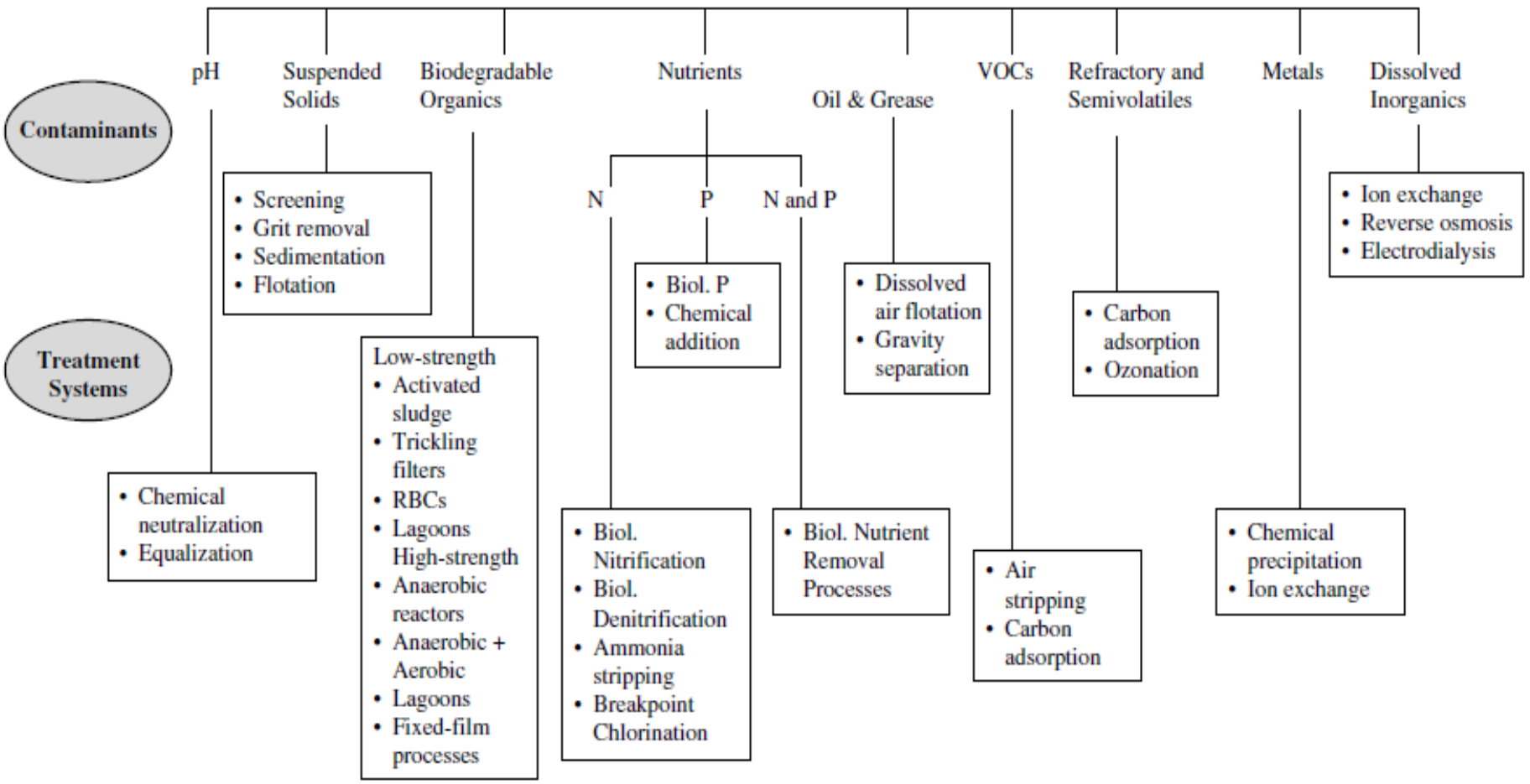
Wastewater Treatment

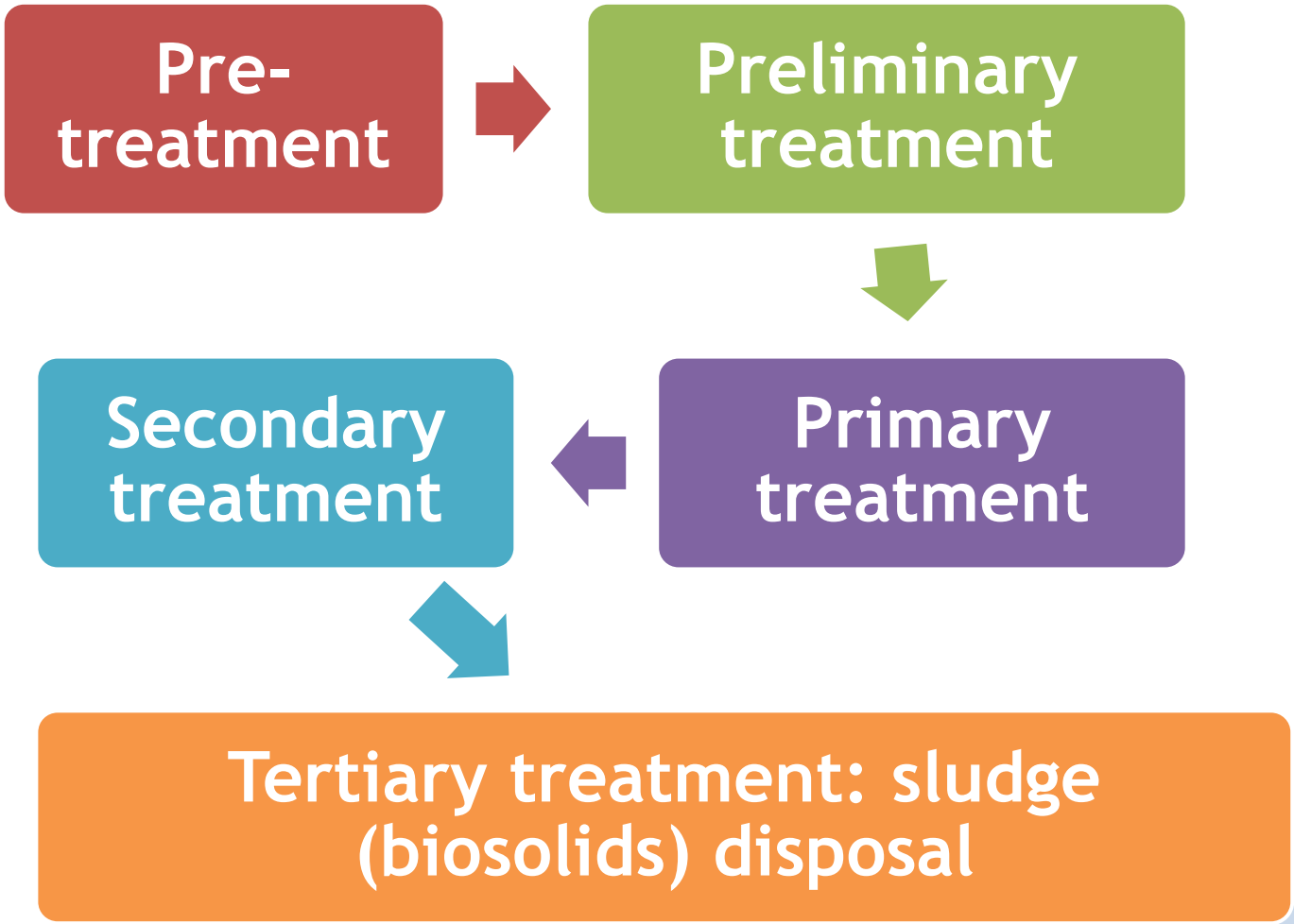
Wastewater Treatment

- **Purpose**
  - To manage water discharged from homes, businesses, and industries to reduce the threat of water pollution.

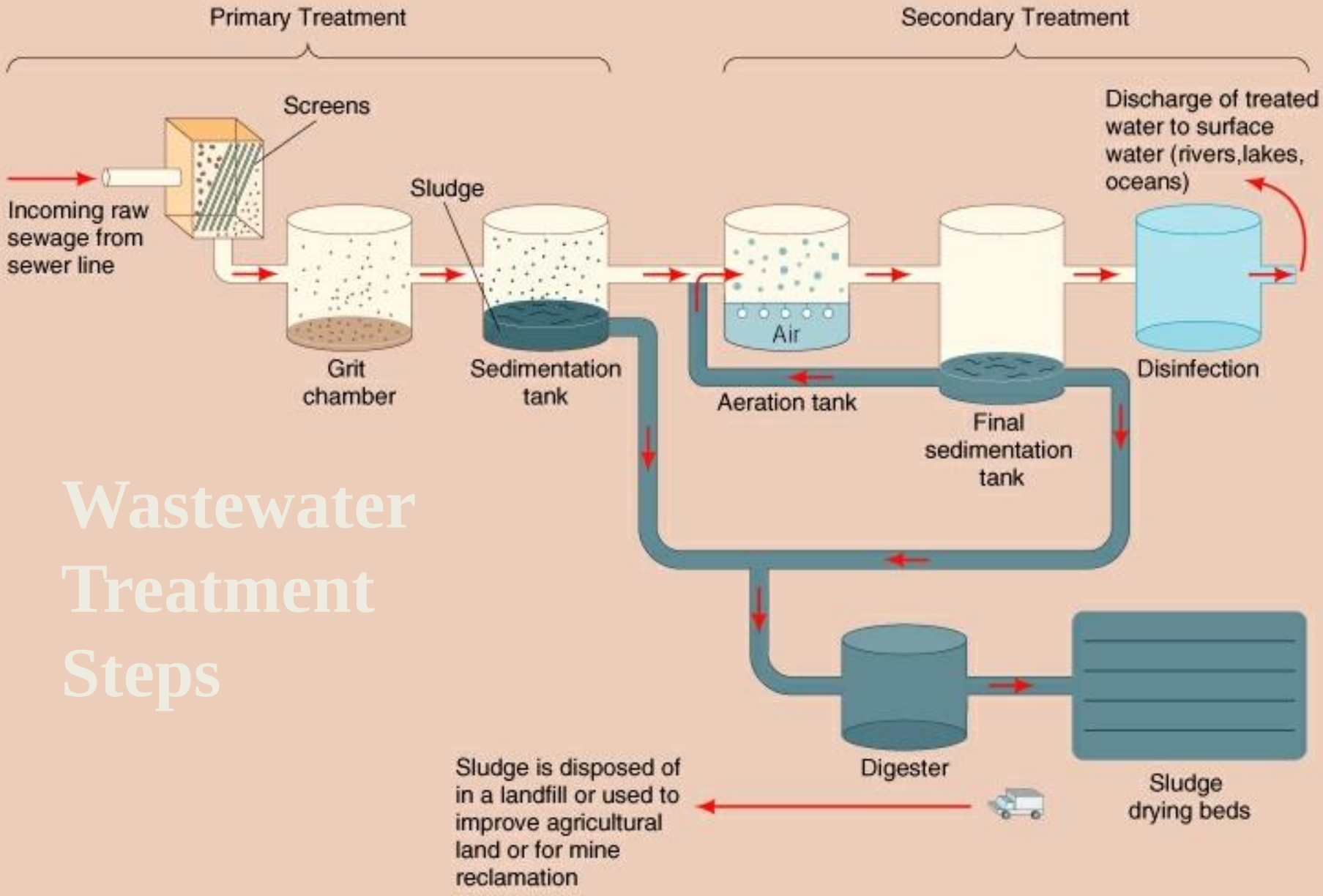
Pretreatment Program Requirements for Industrial Wastewater



Wastewater Treatment Steps



Wastewater Treatment Steps



Wastewater Treatment

- Water discharged from homes, businesses, and industry enters sanitary sewers.
- Water from rainwater on streets enters storm water sewers. Combined sewers carry both sanitary wastes and storm water.
- Water moves toward the wastewater plant primarily by gravity flow
- Lift stations pump water from low lying areas over hills.

Pre-treatment

- Occurs in business or industry prior to discharge
- Prevention of toxic chemicals or excess nutrients being discharged in wastewater

Preliminary Treatment

- Removes large objects and non-degradable materials
- Protects pumps and equipment from damage
- Bar screen and Grit chamber are used

Bar Screen

- Catches large objects that have gotten into sewer system such as bricks, bottles, pieces of wood, etc.

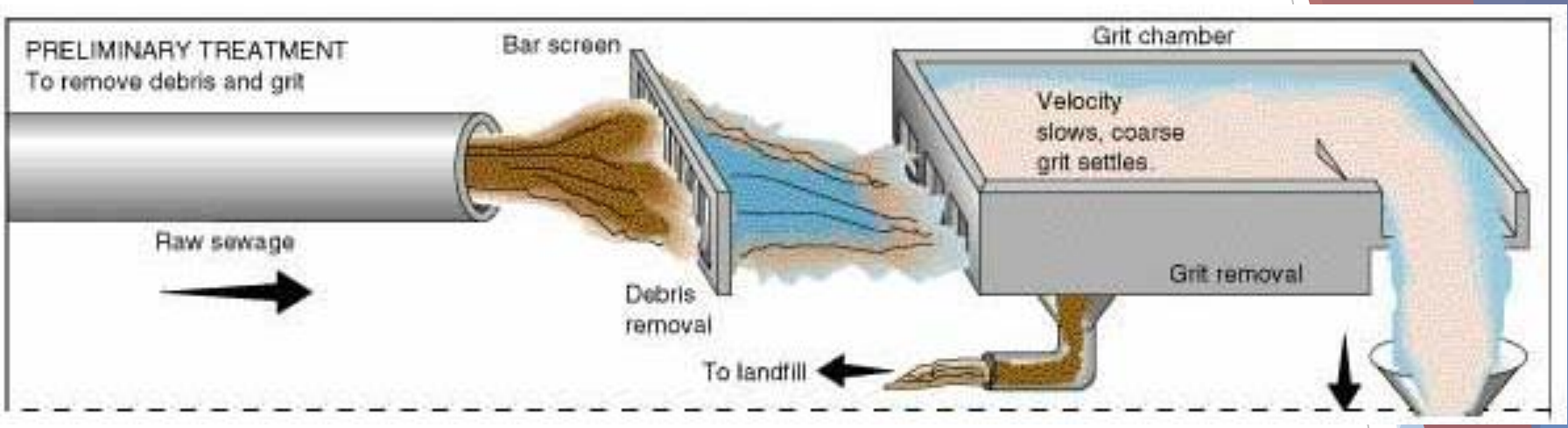
Grit Chamber (تراب وحجار)

- Removes rocks, gravel, broken glass, etc.

Mesh Screen

- Removes diapers, combs, towels, plastic bags, syringes, etc.

Preliminary Treatment



Measurement & Sampling of Inlet Structure

- Flow meter continuously records the volume of water entering the treatment plant
- Water samples are taken for determination of suspended solids and BOD.

Suspended Solids & BOD

- **Suspended Solids**
  - the quantity of solid materials floating in the water column
- **Biological Oxygen Demand (BOD)**
  - a measure of the amount of oxygen required to aerobically decompose organic matter in the water

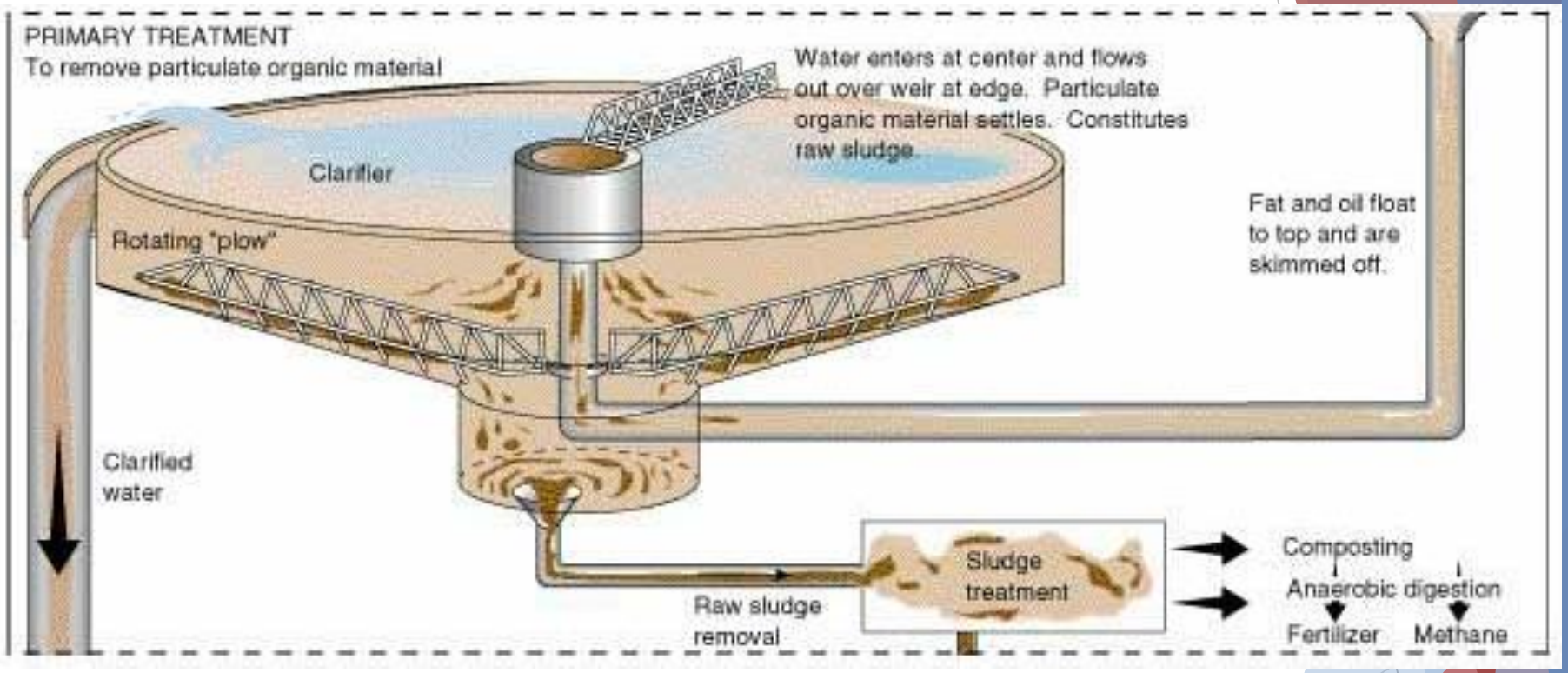
Suspended Solids & BOD

- Measurements of Suspended Solids and BOD indicate the effectiveness of treatment processes
- Both Suspended Solids and BOD decrease as water moves through the wastewater treatment processes

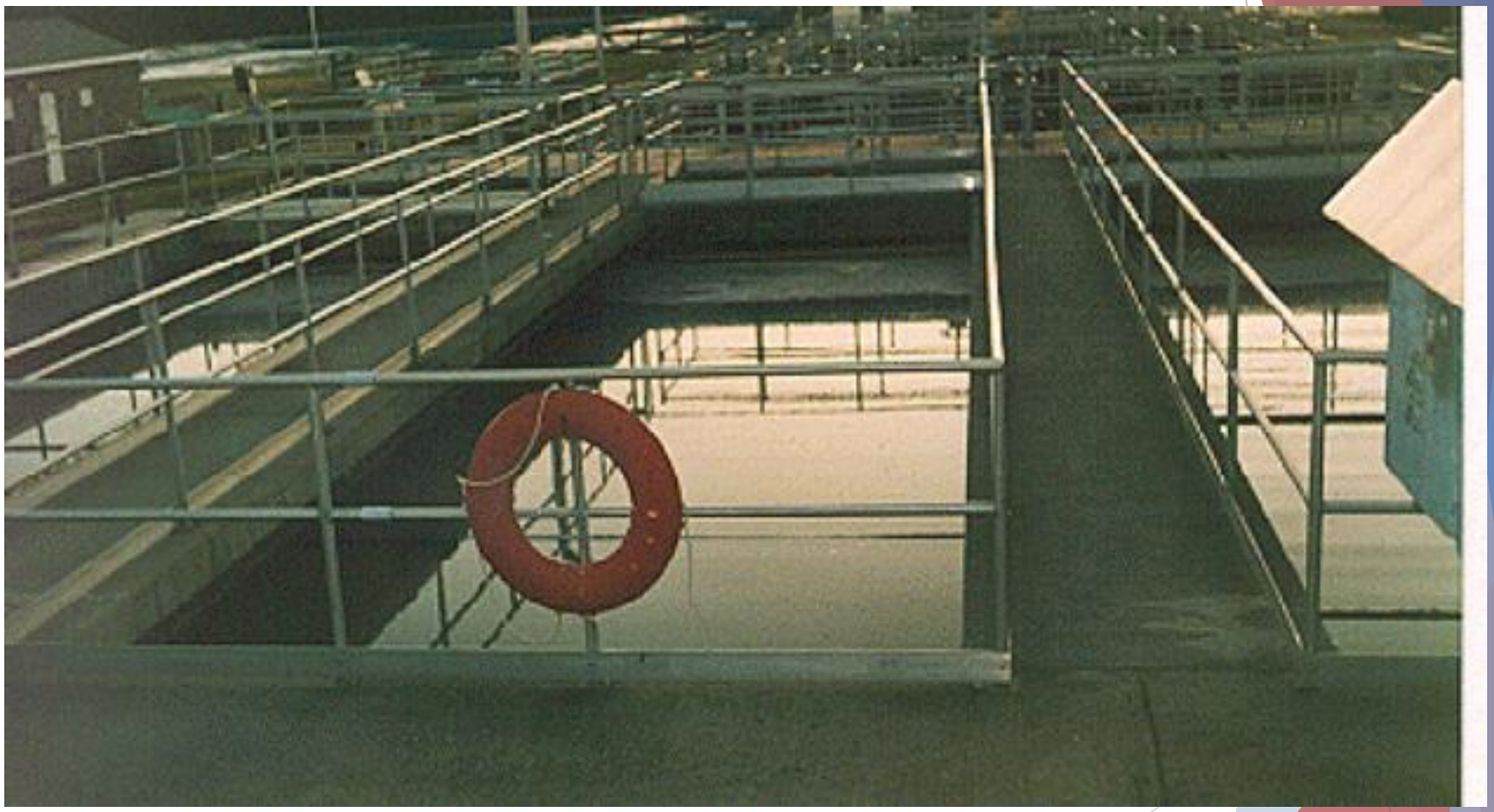
Primary Treatment

- A physical process
- Wastewater flow is slowed down and suspended solids settle to the bottom by gravity
- The material that settles is called sludge or biosolids

Clarifier in Primary Treatment



Primary Treatment



Primary Treatment

- Sludge from the primary sedimentation tanks is pumped to the sludge thickener.
- More settling occurs to concentrate the sludge prior to disposal

Primary Treatment

- Primary treatment reduces the suspended solids and the BOD of the wastewater.
- From the primary treatment tanks, water is pumped to the trickling filter for secondary treatment.
- Secondary treatment will further reduce the suspended solids and BOD of the wastewater.

Secondary Treatment

- Secondary treatment is a biological process
- It utilizes bacteria, protozoa and algae to metabolize organic matter in the wastewater
- Human waste, food waste, soaps, and detergents are some examples of sewage biological content (dissolved organic matter)

Secondary Treatment

Microbial Action

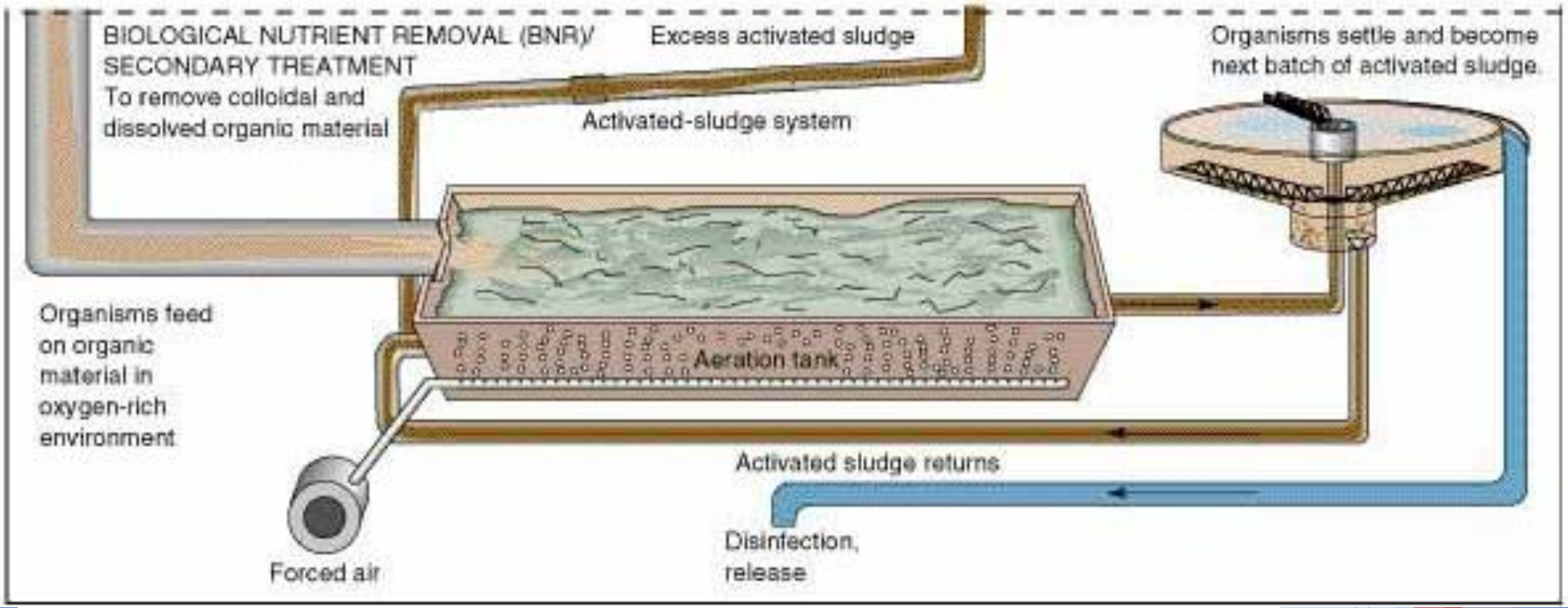
- The organic waste is consumed by microbial action. This microbial action can be divided into two categories:
  - free swimming
  - fixed media filters
- In **free-swimming** systems, the microorganisms are free-swimming in the water, so they must be cycled through the system. After being used to break down BOD, they are removed from the wastewater in a clarifier and returned to the aeration chamber or oxidation ditch.
- Packaged plants and oxidation ditches are an example of the free swimming microbial action.

Secondary Treatment

Microbial Action

- In contrast, **fixed media filters** use microorganisms attached to a medium (rocks, plastic, metal, etc.) The microorganisms stay in place and do not need to be cycled through the system. Instead, wastewater is circulated past the fixed microorganisms.
- A fixed media filter mimics the treatment method used in a healthy stream in which microorganisms produce a slick coating on rocks and pebbles. This coating of microorganisms is able to trap and consume BOD and ammonia in the water.

Secondary Treatment



Secondary Treatment

- From secondary treatment, e.g., the trickling filter, water flows to the final clarifiers for further removal of sludge.
- The final clarifiers are another set of primary sedimentation tanks. They remove additional sludge and further reduce suspended solids and BOD.
- From the final clarifiers the water is discharged out.

Disposal of Sludge or Biosolids

- The sludge undergoes lime stabilization (pH is raised by addition of lime) to kill potential pathogens
- The stabilized sludge is land applied by injection into agricultural fields

Secondary Treatment

- **Three different approaches**
  - Fixed film system (trickling filter)
  - Suspended film system
  - Lagoon system

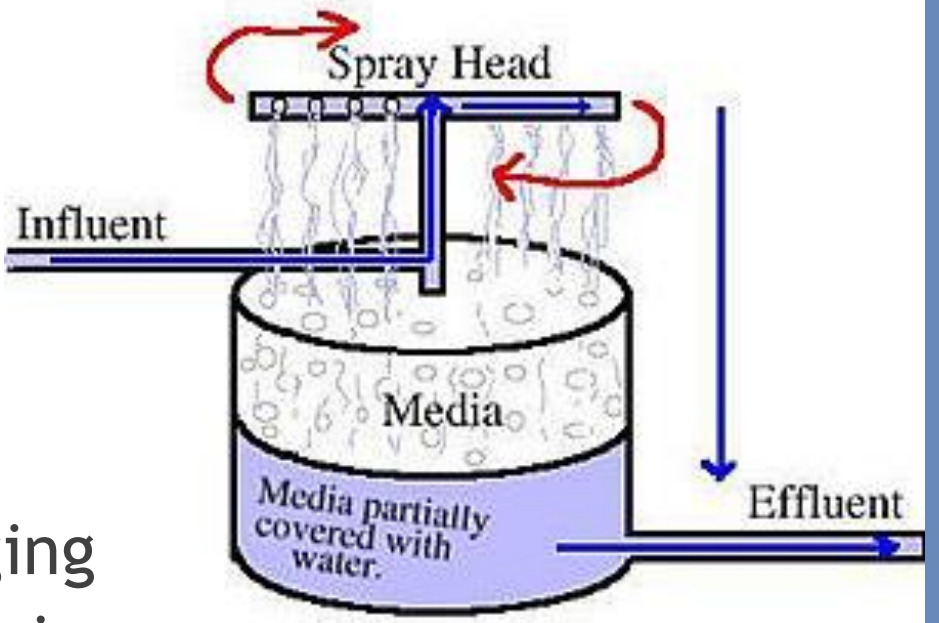
Secondary Treatment Approaches

(1) Fixed Film Systems

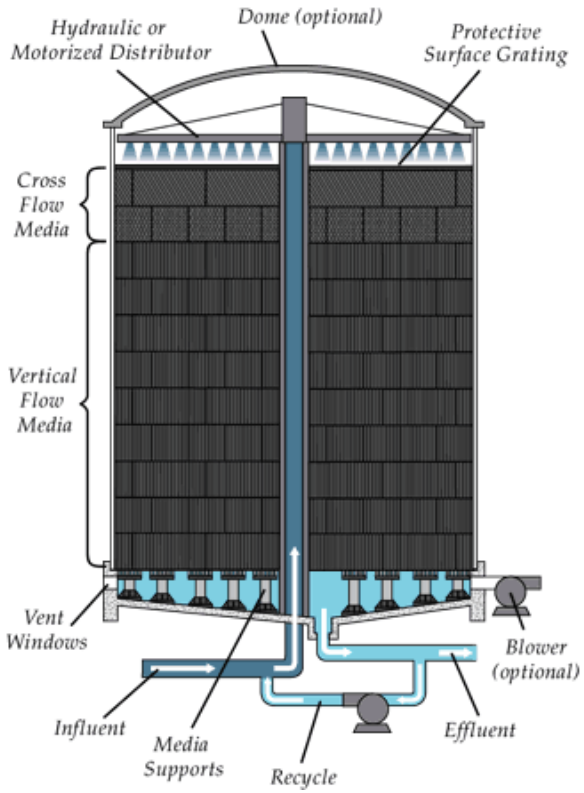
- grow microorganisms on substrates such as rocks, sand or plastic
- wastewater is spread over the substrate
- Example: Trickling filters,
  rotating biological contactors

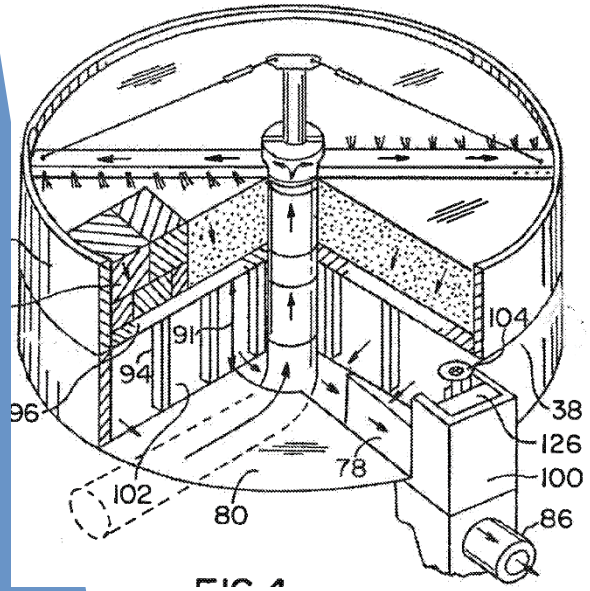
(1) Fixed Film Systems

Trickling filter



- The trickling filter does not “filter” the water. Water runs over a plastic media and organisms clinging to the media remove organic matter from the water.
- Wastewater is distributed evenly over the surface of the trickling filter media. As the wastewater flows over the media the organisms remove the organic matter from the flow.


Hydraulic or
Motorized Distributor
Dome (optional)
Protective
Surface Grating
Cross
Flow
Media
Vertical
Flow
Media
Vent
Windows
Blower
(optional)
Influent
Media
Supports
Recycle
Effluent


104
91
94
96
38
126
78
100
102
80
86

(1) Fixed Film Systems

Trickling filter

- Spread wastewater over microorganism
- Made of coke (carbonised coal), limestone chips or specially fabricated plastic media
- Optimize their thickness by insect or worm grazing

(2) Lagoon Systems

- Hold the waste-water for several months
- Natural degradation of sewage

(3) Suspended Film Systems

- Stir and suspend microorganisms in wastewater
- Settled out as a sludge
- Pumped back into the incoming wastewater
- Example: Activated sludge,
  extended aeration

3) Suspended Film Systems

Activated sludge

- Mixed community of microorganisms
- Both aerobic and anaerobic bacteria may exist
- Biological floc is formed

3) Suspended Film Systems

Activated Sludge Process

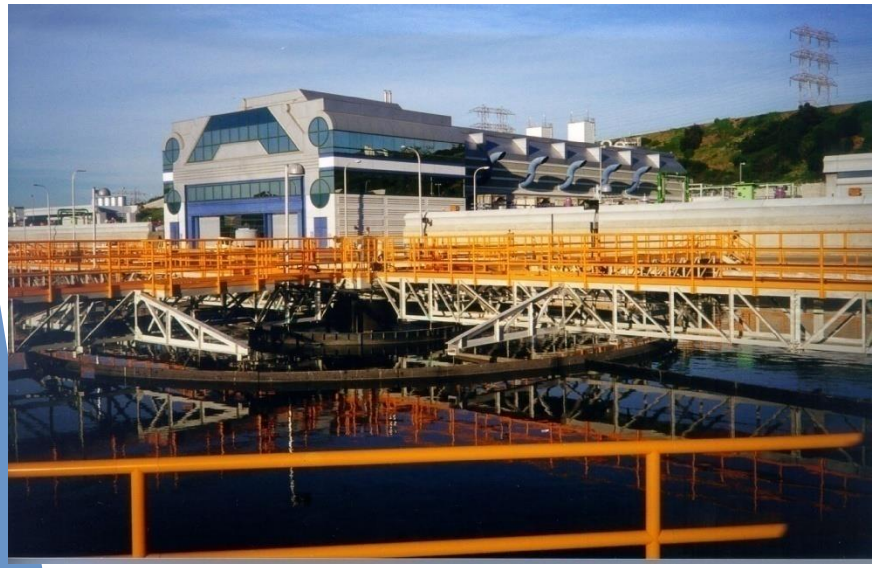
Aeration Tank
- Oxygen is introduced into the system

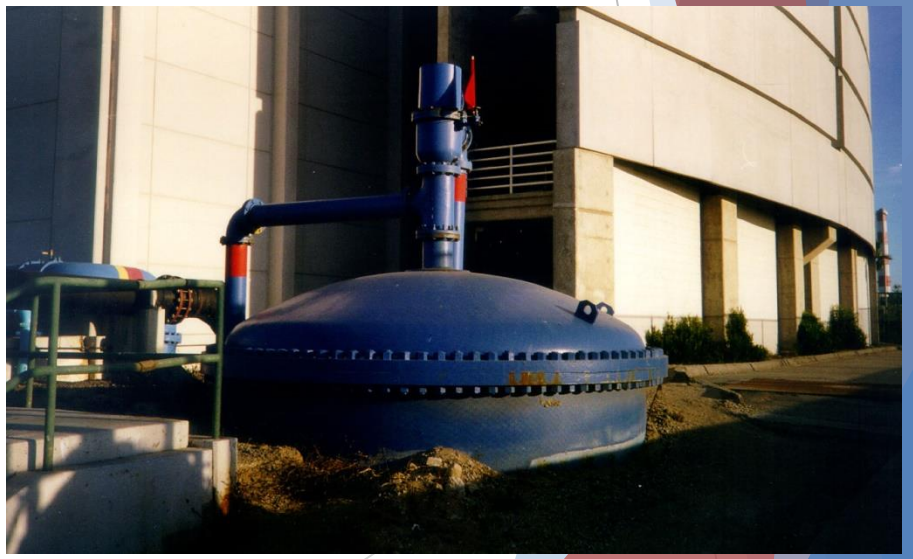
Aeration Source
- Ensure that adequate oxygen is fed into the tank
- Provided as pure oxygen or compressed air

Secondary Clarifiers
- Activated-sludge solids are separated from the surrounding wastewater

Activated Sludge Outflow Line
- Pump activated sludge back to the aeration tank

Effluent Outflow Line
- Discharge effluent into bay or tertiary treatment plant





Tertiary Treatment

- Remove disease-causing organisms from wastewater
- Three different disinfection processes
  - Chlorination
  - UV light radiation
  - Ozonation

Disinfection Processes

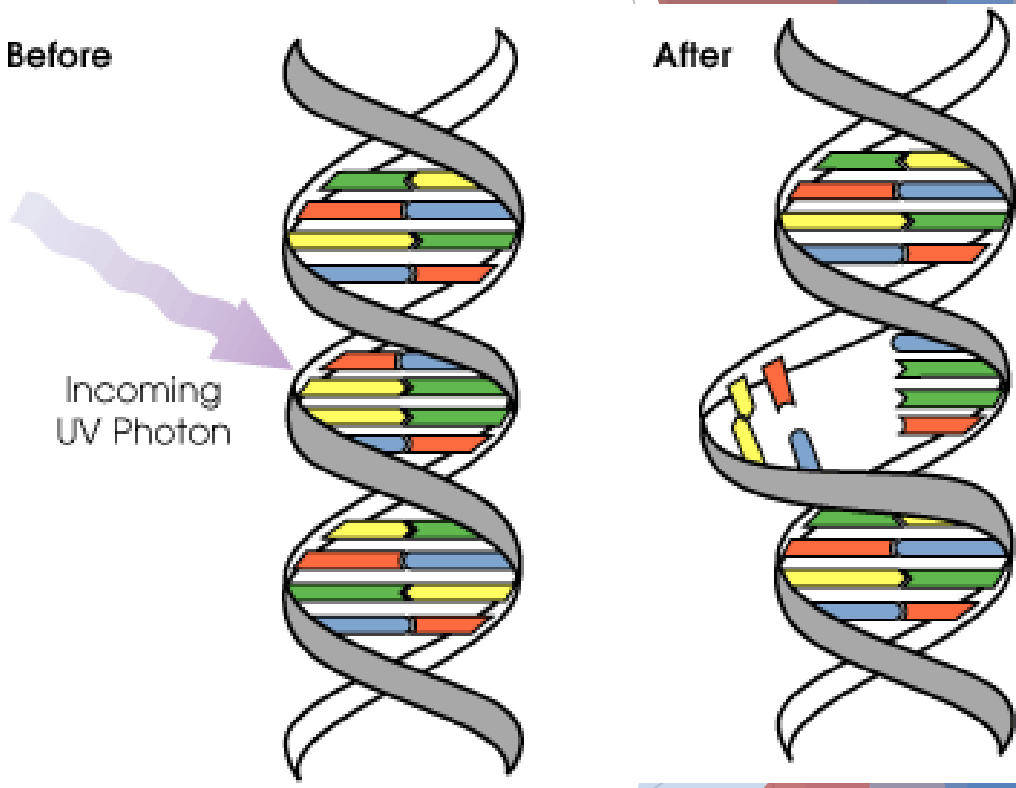
Chlorination

- Most common
- **Advantages**: low cost & effective
- **Disadvantages**: chlorine residue could be harmful to environment

Disinfection Processes

UV Light Radiation

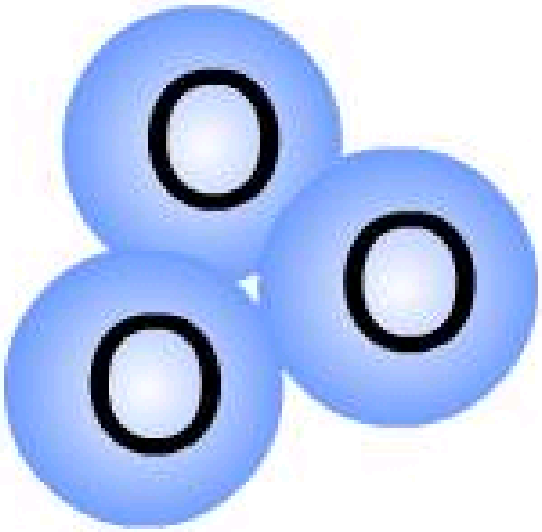
- Damage the genetic structure of bacteria, viruses and other pathogens.
- **Advantages**:
  - no chemicals are used
  - water taste more natural
- **Disadvantages**: high maintenance of the UV-lamp



Disinfection Processes

Ozonation

- Oxidize most pathogenic microorganisms
- **Advantages**: safer than chlorination, fewer disinfection by-product
- **Disadvantage**: high cost



What can Effluent Treated Water be Used for?

- Can be discharged into a stream, river, bay, lagoon or wetland
- Can be used for general irrigation purposes
- If sufficiently clean, it can be used for groundwater recharge

Sludge Treatment

- Primary sludge usually have strong odors
- Secondary sludge have high concentration of microorganism
- **Goals of Sludge Treatments:**
  - Reduce odors
  - Remove water to reduce volume
  - Decompose organic matter

Sludge Treatment

- Untreated sludge are about 97 percent water
- Settling can reduce about 92 to 96 percent of water
- Dried sludge is called ***sludge cake***

Sludge Treatment Methods

- Aerobic digestion
- Anaerobic digestion
- Composting (سماد)

Sludge Treatment Methods

Aerobic Digestion

- Bacterial process
- Needs oxygen
- Consumes organic matter
- Converts organic matter into carbon dioxide (CO_2)

Sludge Treatment Methods

Anaerobic digestion

- Bacterial process
- Does not require oxygen
- Consumes organic matter
- Produces biogas, which can be used in generators for electricity

Sludge Treatment Methods

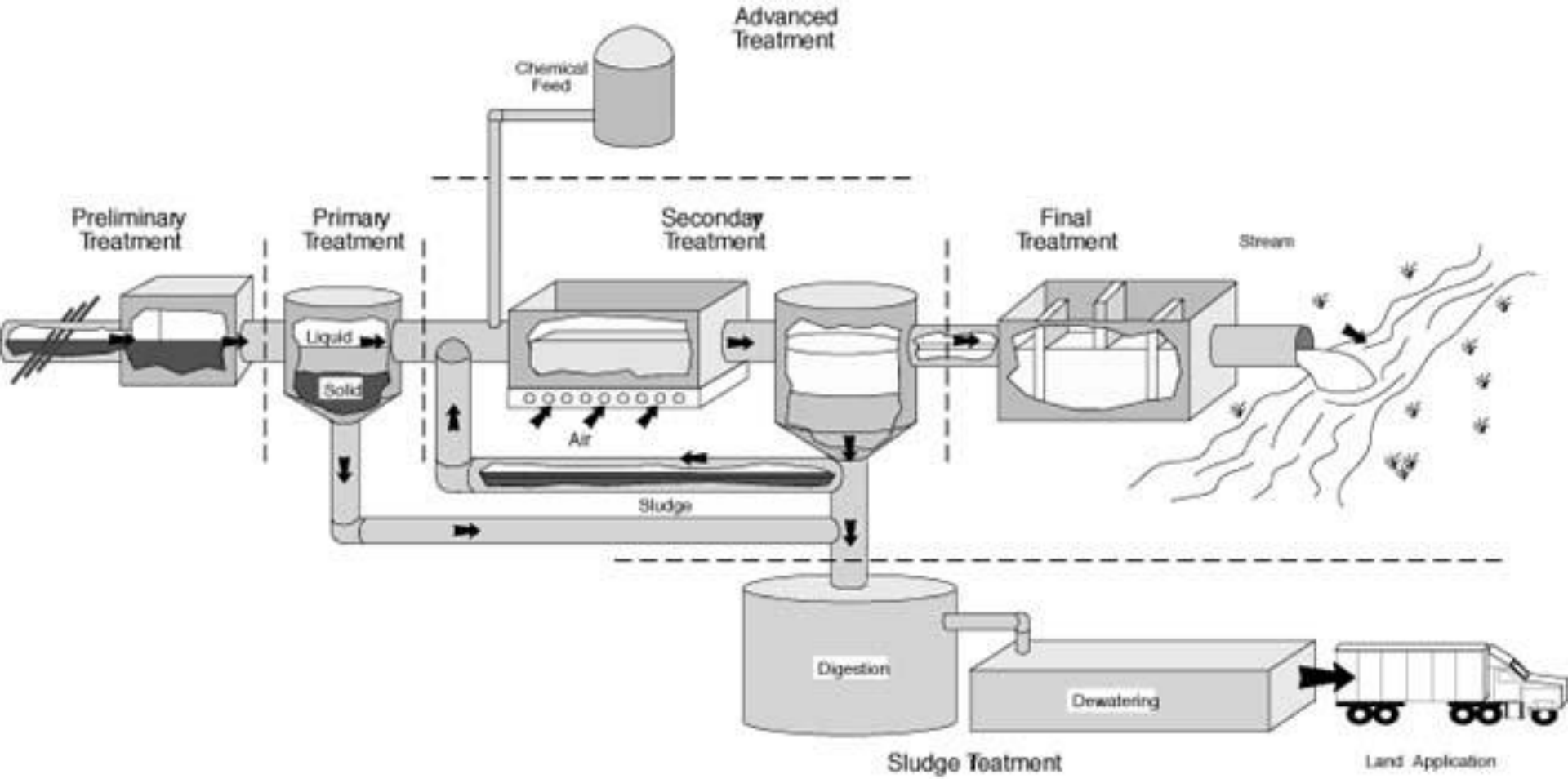
Composting

- Aerobic process
- Requires the correct mix of carbon, nitrogen, oxygen and water with sludge
- Generate large amount of heat

Sludge Disposal

- Superheat sludge and convert it into small granules that are rich in nitrogen
  - Sell it to local farmer as fertilizer
- Spread sludge cake on the field
- Save landfill space

Summary


Advanced Treatment
Chemical Feed
Preliminary Treatment
Primary Treatment
Secondary Treatment
Final Treatment
Stream
Liquid
Solid
Air
Sludge
Digestion
Dewatering
Sludge Treatment
Land Application