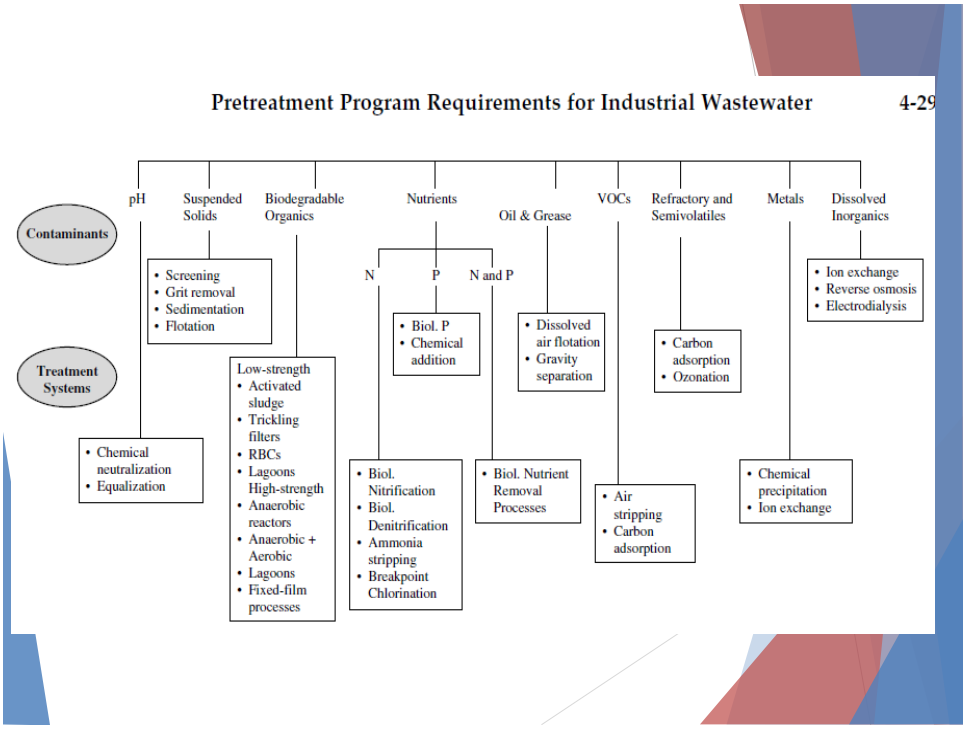
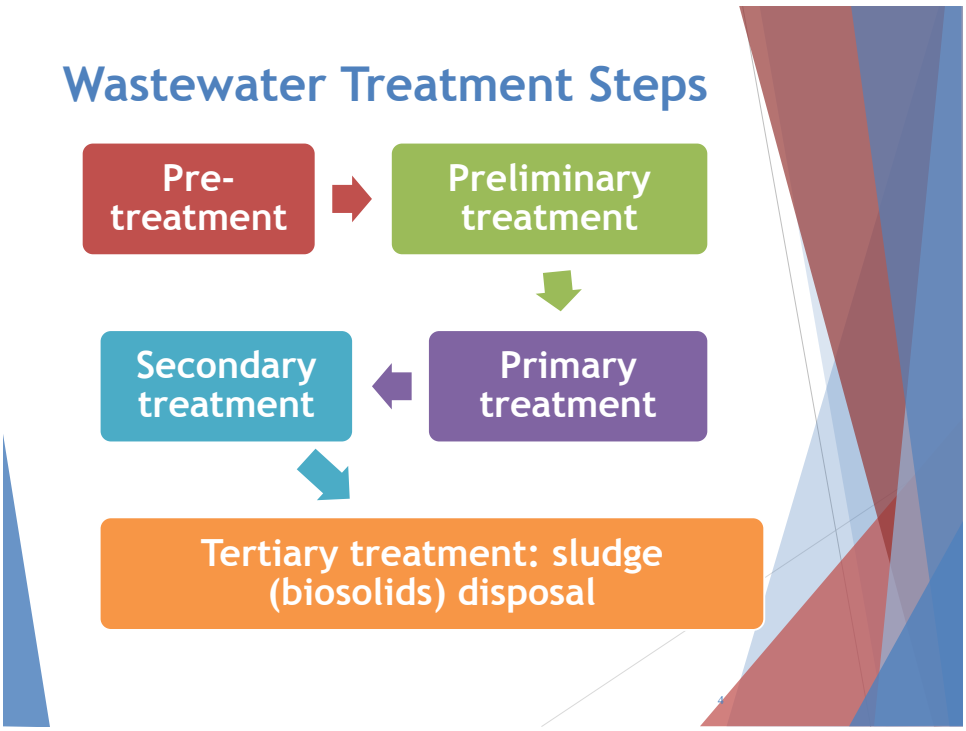
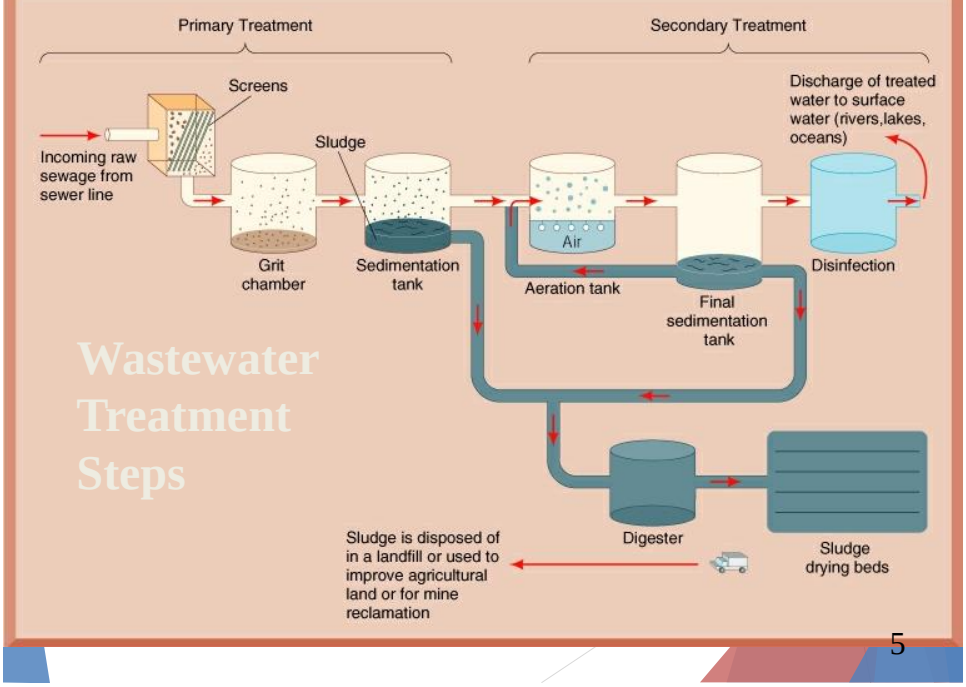
Wastewater Treatment

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 4-29
Contaminants
Treatment Systems
pH
Suspended Solids
Biodegradable Organics
Nutrients
N
P
N and P
Oil & Grease
VOCs
Refractory and Semivolatiles
Metals
Dissolved Inorganics
• Chemical neutralization
• Equalization
• Screening
• Grit removal
• Sedimentation
• Flotation
Low-strength
• Activated sludge
• Trickling filters
• RBCs
• Lagoons
High-strength
• Anaerobic reactors
• Anaerobic + Aerobic
• Lagoons
• Fixed-film processes
• Biol. Nitrification
• Biol. Denitrification
• Ammonia stripping
• Breakpoint Chlorination
• Biol. P
• Chemical addition
• Biol. Nutrient Removal Processes
• Dissolved air flotation
• Gravity separation
• Air stripping
• Carbon adsorption
• Carbon adsorption
• Ozonation
• Chemical precipitation
• Ion exchange
• Ion exchange
• Reverse osmosis
• Electrodialysis


Wastewater Treatment Steps
Pre-treatment
Preliminary treatment
Primary treatment
Secondary treatment
Tertiary treatment: sludge (biosolids) disposal



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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.

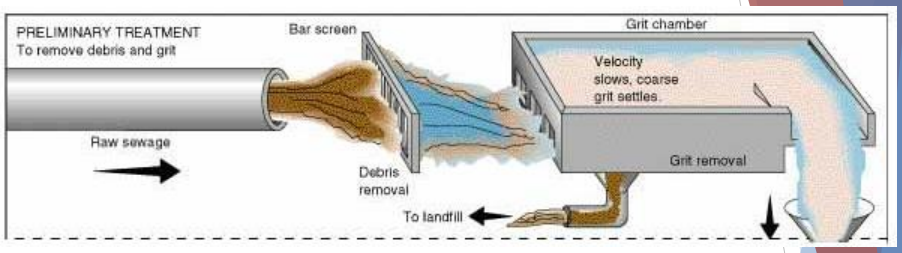
Grit Chamber (تراب وحجار)

- Removes rocks, gravel, broken glass, etc.

Mesh Screen

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

Preliminary Treatment



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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.

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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

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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

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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

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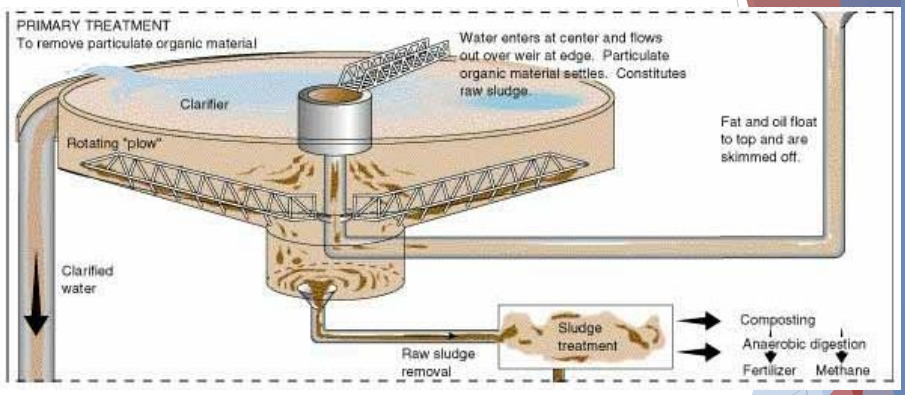
Clarifier in Primary Treatment



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Primary Treatment

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Primary Treatment

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

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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.

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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)

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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.

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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.

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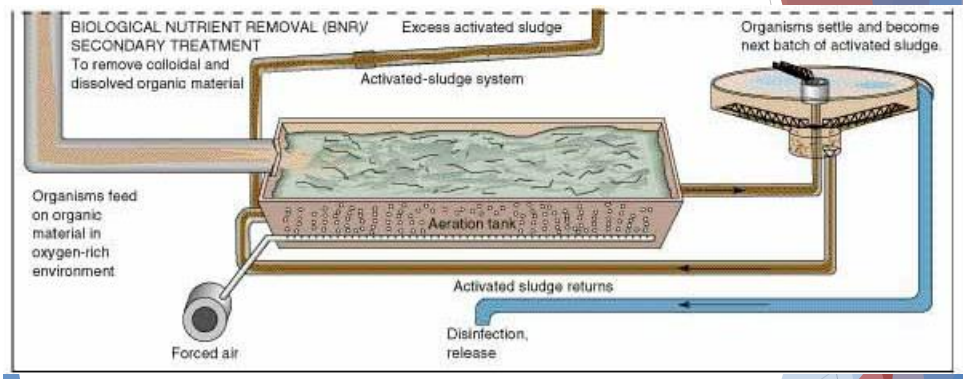
Secondary Treatment



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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.

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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

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Secondary Treatment

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

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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

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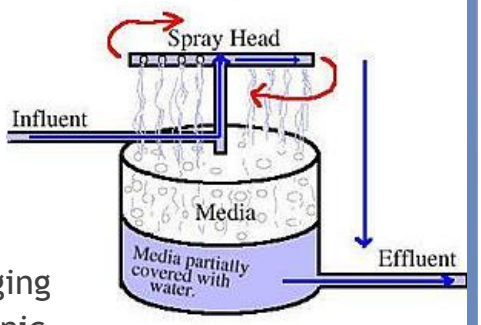
(1) Fixed Film Systems

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.

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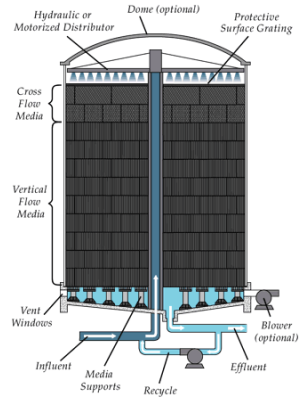

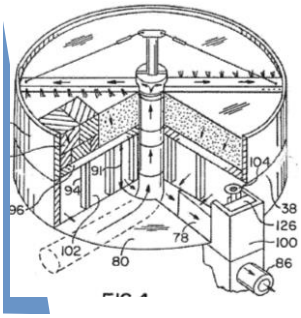

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(1) Fixed Film Systems

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

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(2) Lagoon Systems

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

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(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

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3) Suspended Film Systems

Activated sludge

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

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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 separate 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

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Tertiary Treatment

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

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Disinfection Processes

Chlorination

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

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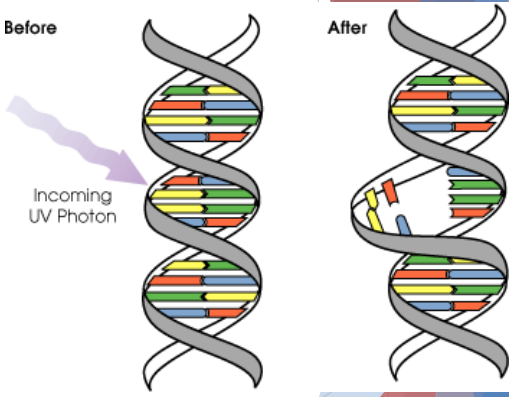
Disinfection Processes

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



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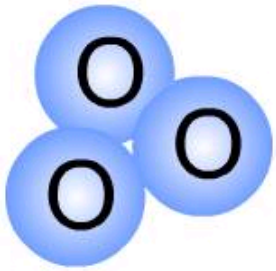
Disinfection Processes

Ozonation

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



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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

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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

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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***

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Sludge Treatment Methods

- Aerobic digestion
- Anaerobic digestion
- Composting (سماد)

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Sludge Treatment Methods

Aerobic Digestion

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

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Sludge Treatment Methods

Anaerobic digestion

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

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Sludge Treatment Methods

Composting

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

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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

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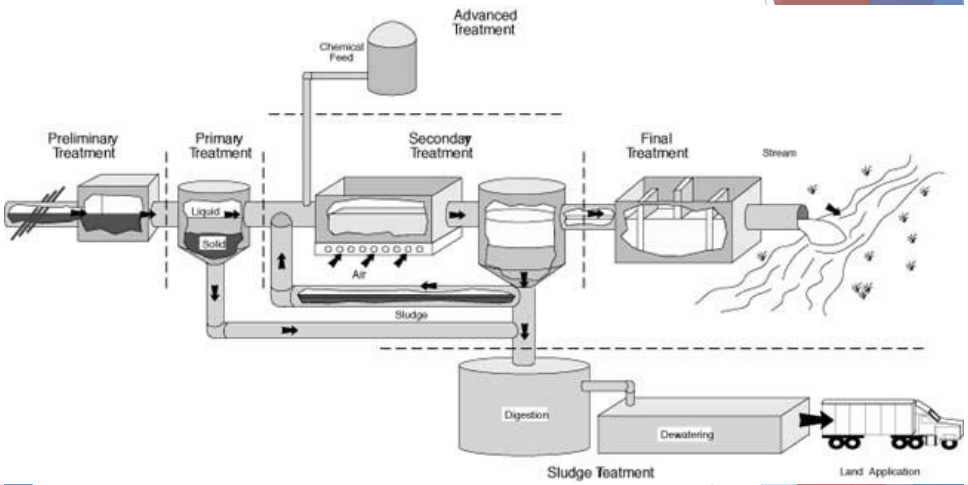
Summary



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