# Wastewater Treatment Process Overview

Wednesday, February 22, 2023

This program is made possible under a cooperative agreement with US EPA



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## Operator Certification

- Certification programs are regulated by the states
  - Texas- TCEQ, New Mexico- NMED, Oklahoma- ODEQ
- Certification levels (1-4, D-A, etc.)
  - Complexity of the system
  - Population
  - Experience
- Available resources
  - California State University, Sacramento- Wastewater operation manuals
  - State distributed resources and need to know lists
- Certification exam- Study!!

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## Why do we treat wastewater?

- Protect fresh water supplies
- Public health
- Environmental health
- Required by EPA regulations

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## What do we treat wastewater for?

- Excess nutrients (BOD, nitrogen and phosphorus)
- Pathogens
- Solids/ debris
- Others (pH, metals, emerging contaminants)

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## General treatment processes

- Preliminary treatment
- Primary treatment
- Secondary treatment
- Tertiary treatment
- Disinfection
- Sludge handling

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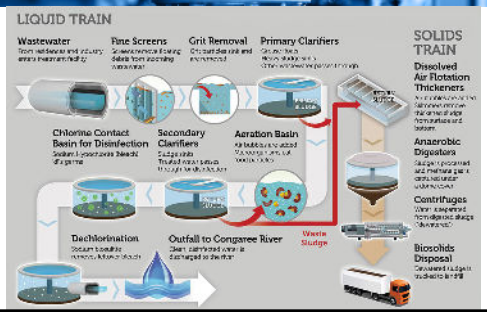


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## Important wastewater concepts

- BOD- Amount of oxygen consumed at 20°C
- Carbon Cycle- Aerobic and anaerobic respiration
- Nitrogen Cycle- Manipulated to removes ammonia ($NH_3$) and nitrate ($NO_3$)
- Sulfur Cycle- Results in sulfuric acid and hydrogen sulfide ($H_2S$) gas
- Specific Gravity- Density of a substance compared to water. Used to create physical separation of solids from wastewater

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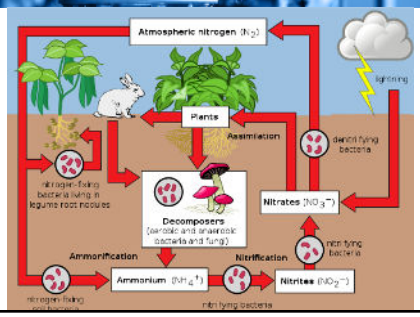
## Nitrogen Cycle

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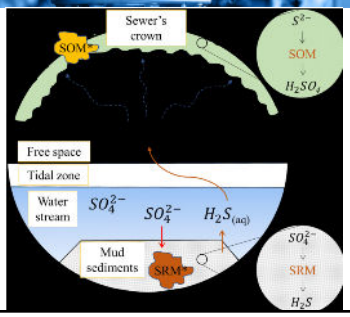
## Sulfur Cycle

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## Typical Influent Pollutant Concentrations

| Parameter | Influent Concentration | Effluent Goal |
|---|---|---|
| BOD5 | 200 mg/L | < 30 mg/L |
| TSS | 200 mg/L | < 30 mg/L |
| TDS | 800 mg/L | < 1000 mg/L |
| Settleable Solids | 10 mL/L | < 0.1 mg/L |
| pH | 6- 9 | 6- 9 |
| Fecal Coliform | Too numerous to count | < 500 cfu/ 100mL |
| TKN (Ammonia + Organic Nitrogen | 30 mg/L | < 10 mg/L Total Nitrogrn |
| Nitrate/ Nitrate (Inorganic Nitrogen) | < 1.0 mg/L | |
| Phosphorus | 2.0 mg/L | < 1.0 mg/L |
| Fats, Oils, and Grease | Varies greatly | None Visible |
| | 30/45 Effluent Rule | |
| Parameter | 30-day average | 7-day averge |
| BOD5 | 30 mg/L | 45 mg/L |
| TSS | 30 mg/L | 45 mg/L |

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## Pretreatment

- Larger solids and rags
- Grit removal
- Flow measurement
- Flow equalization

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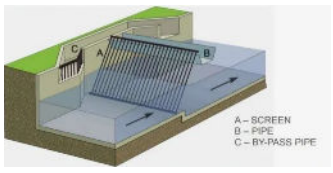
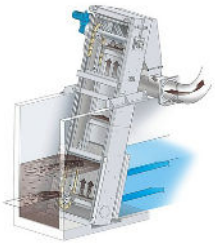
## Bar Screens



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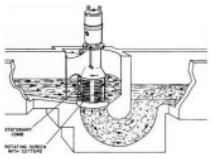
## Comminutors

- Rags and debris are shredded and left in the water
- Can clog equipment and be labor intensive
- Require electricity unlike manual bar screens



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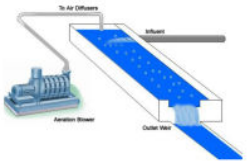
## Grit Removal



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## Flow Measurement

- MGD, gpm, and cfs
- Ultrasonic meter
- Flume
- Weir with staff gage
- Bubbler
- Venturi Meters or Magnetic for inline pipe

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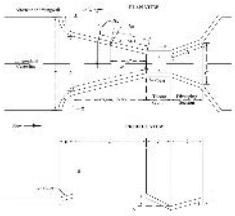
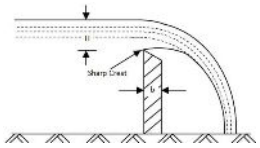
## Flow Measurement Devices





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## Primary Treatment

- Primary clarification
  - Removes 90-95% of settleable solids
  - 40-60% of suspended solids
  - 30-40% of BOD
- Sludge removal

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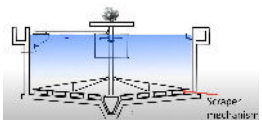
## Primary Clarifier



- Consists of a tank, scraper, drive unit, influent baffle, weir, and scum trey/trough
- Primary sludge: 4-8% dry solids
- Detention Time: 2-3 hours
- Weir Overflow Rate: 10,000-20,000 gpd
- Surface Loading Rate: 300-1,200 gpd/sq. ft

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## Secondary Treatment

- Designed to remove BOD, $NH_3$ and $NO_3$
- Comes in many shapes and sizes
- Derived from naturally occurring microorganisms found in wastewater
- Can be fixed film or suspended growth
- Can require secondary clarification

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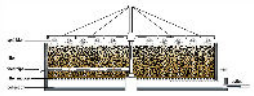
## Trickling Filters



- Similar structure to a clarifier filled with rocks.
- Rocks covered in zoogleal film
- Typical plant efficiency is 90% removal of BOD and suspended solids

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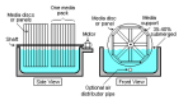
## Rotating Biological Contactors (RBCs)



- Same fixed-media concept as Trickling Filters
- Cylinders made of plastic sheets that allow for media growth and air distribution
- Rotates at 1.5 rpm and 40% of contactor is submerged

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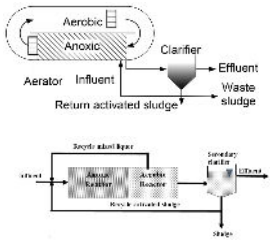
## Activated Sludge

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## Tertiary Treatment

- Required for plants that have a higher effluent quality requirement
- Disinfection for removal of pathogens
- Specialized treatment to removal special contaminants such as mercury, microplastics, PPCPs, excess chlorine etc.

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## Disinfection

- Through chlorination, ozone or UV
- Prevents spread of water borne diseases
- Industry has been shifting from chlorination to UV to mitigate safety hazards

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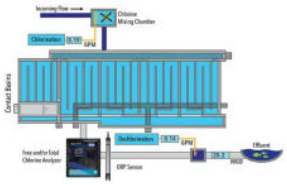
## Chlorination

- Liquid, solid, and gas forms
- Requires chorine residual and occurrence of breakpoint chlorination
- Dechlorination must occur to prevent fish kills



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## UV disinfection

- Safer than chlorination
- No residual required
- Less space intensive
- UV wavelength of 253nm disinfects bacteria

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## Solids Handling

- Pumped primary and secondary sludge must be disposed of properly
- Sludge disposal is regulated due to the presence of pathogens, heavy metals, etc.
- Water must be removed from sludge for transport

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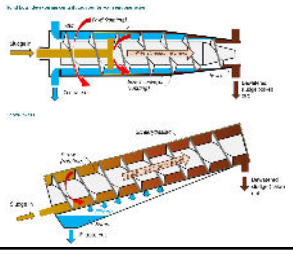
## Solids Handling Technology



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