

Wastewater Characteristics

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Why Treat Wastewater?

- Causes oxygen depletion in receiving stream
- Contains pathogens and/or chemicals
- Unsightly and smelly
- Contributes to eutrophication













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Before Eutrophication



After Eutrophication















To collect and transport wastewater for treatment the following are used:

- Sanitary Sewers
- Storm Sewers
- Combined Sewers

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- In general sewers are designed to flow by gravity

- Design flow is 2 feet per second (fps) to prevent settling and septic conditions



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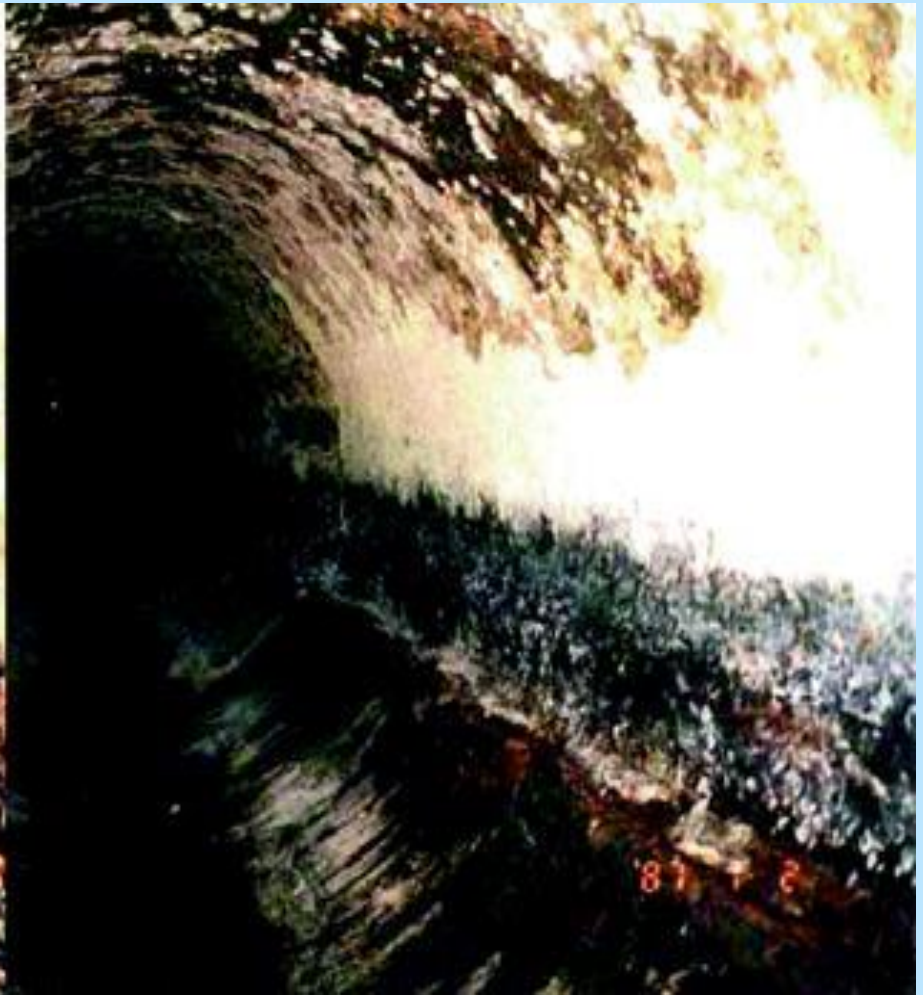
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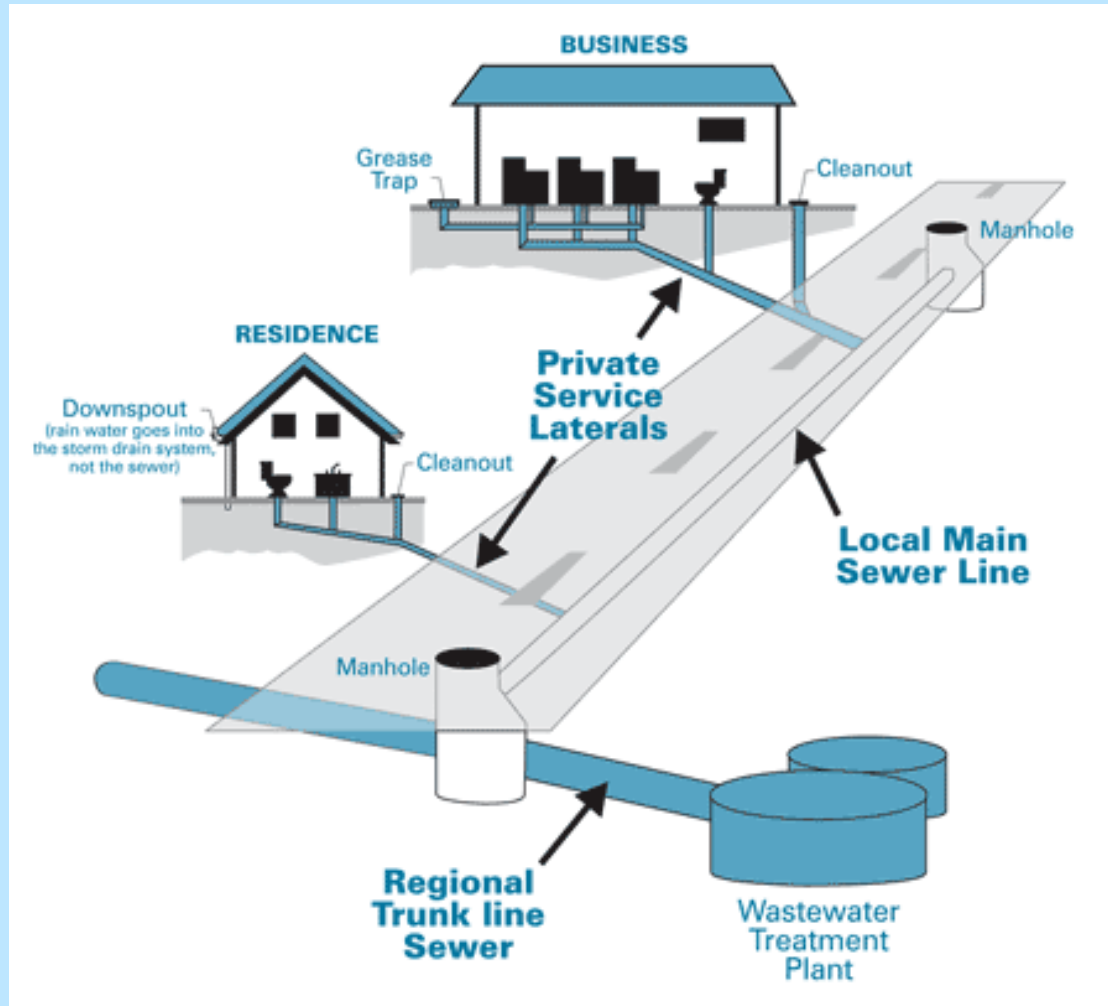
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Manholes are Dangerous

<https://www.spokesman.com/stories/2017/jan/18/three-florida-utility-workers-die-in-manhole-fire/#:~:text=Three%20men%20have%20died%20in%20a%20manhole%20in,Key%20Largo%2C%20Florida%2C%20overcome%20by%20poisonous%20fumes%20underground.>

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In the wastewater treatment plant,
the stages of treatment are:

Preliminary treatment or Pretreatment

Primary Treatment

Secondary Treatment

Sometimes... Tertiary



Treatment Processes

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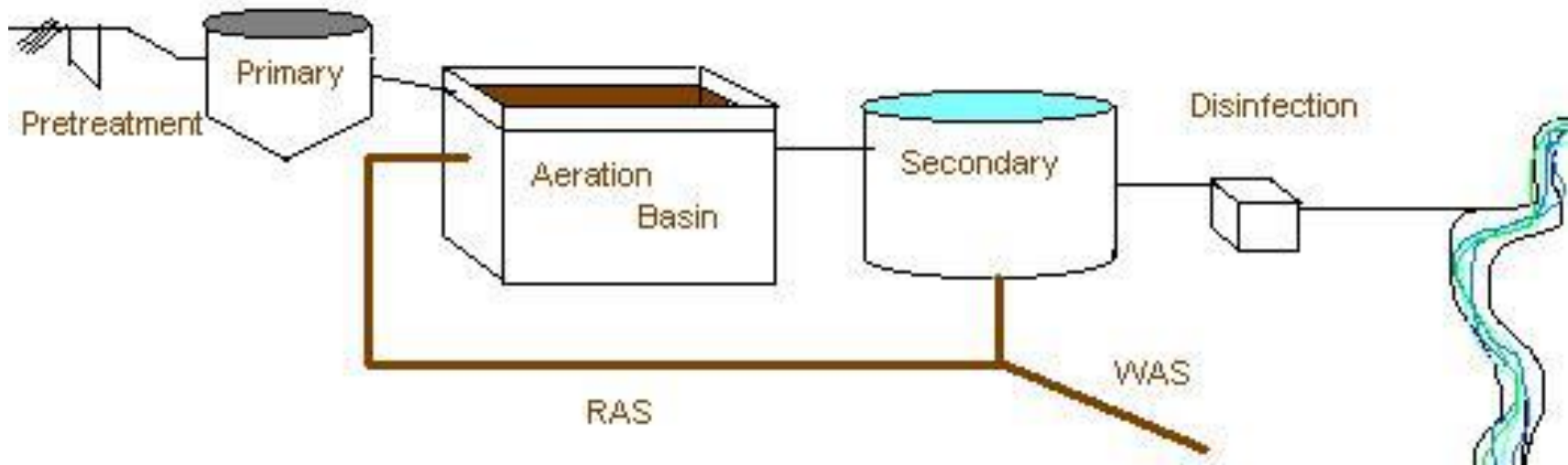
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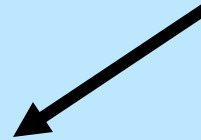
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Preliminary Treatment or Pretreatment

Wastewater - - - -> Headworks



- Screening
- Shredding
- Grit Removal
- Flow Measurement



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Overall purpose of the headworks is...

To protect the equipment in the remainder of the plant and...

To monitor the flow















Screening

Purpose: To remove large, non-biodegradable items from the waste stream such as...
rags, rocks, diapers, etc.

Bar Screens:
Spacing =
3/8" to 2"



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Shredding

Purpose: To reduce in size, cut up and shred “stuff” not removed on the screens or to replace screens and leave shredded material in wastestream.

Types: Barminutor, Comminutor, Muffin Monster, Channel Monster, etc.

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Grit removal

Purpose: To protect the mechanical equipment in the rest of the plant, keep grit out of digester

WHAT'S GRIT? Sand, gravel, egg shells, coffee grounds, seeds, etc.

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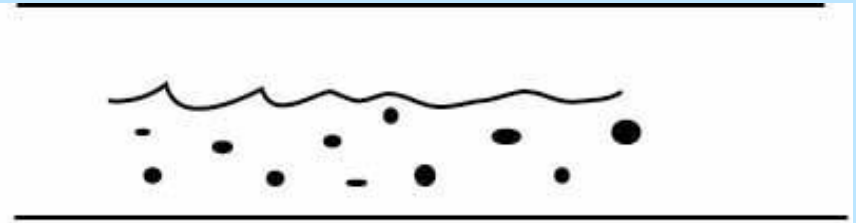
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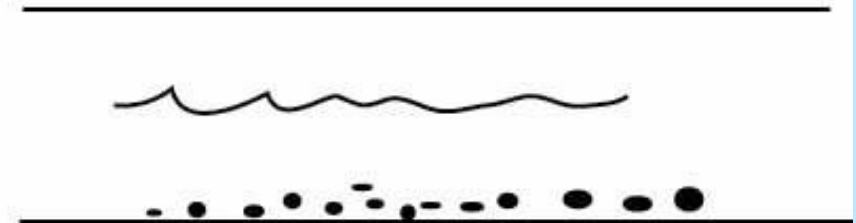
HOW IS GRIT REMOVED?

Sewer



Velocity = 2 ft/sec

Grit Chamber



Velocity = 1.0 ft/sec

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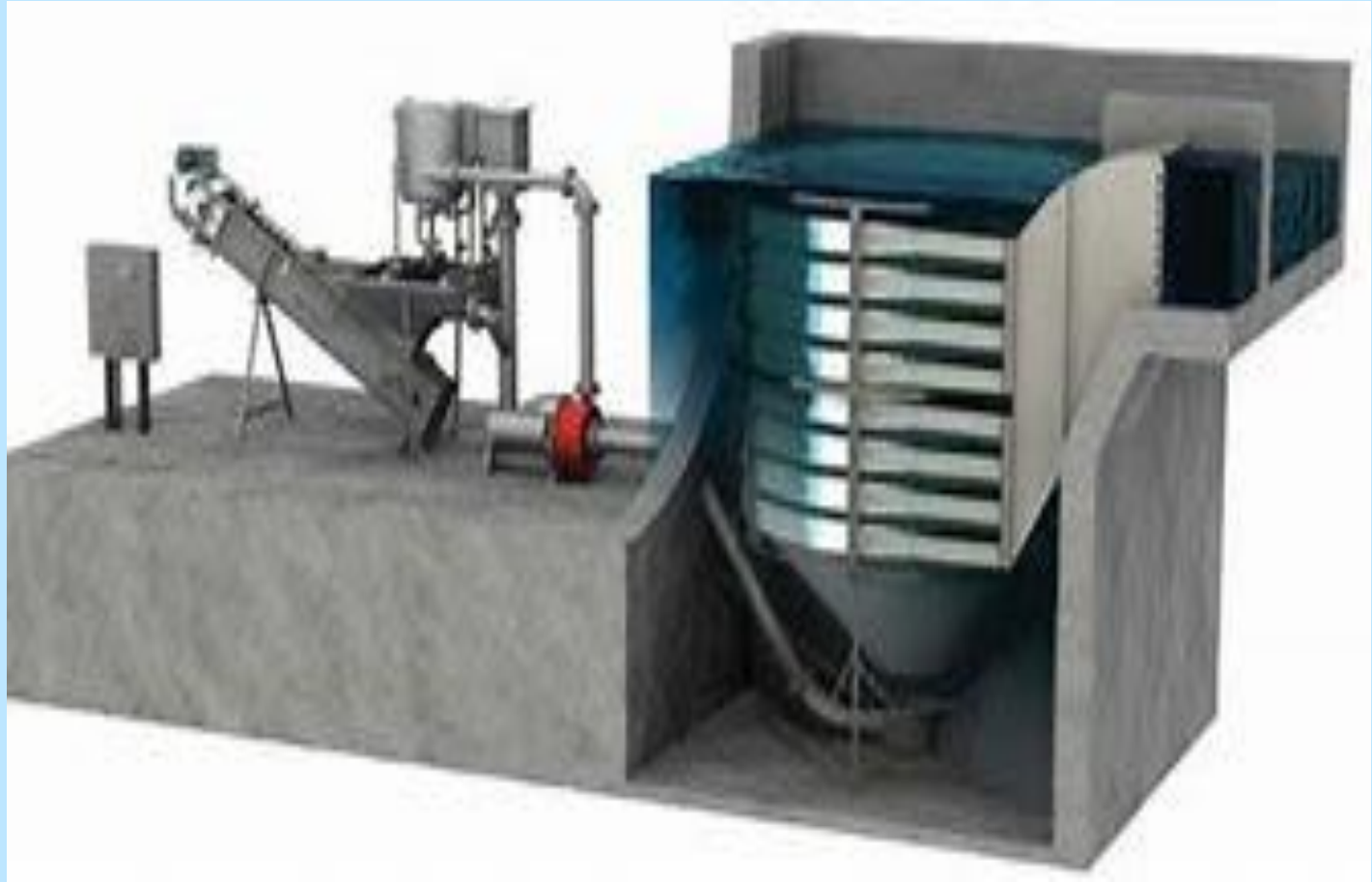
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Aerated Grit Channel



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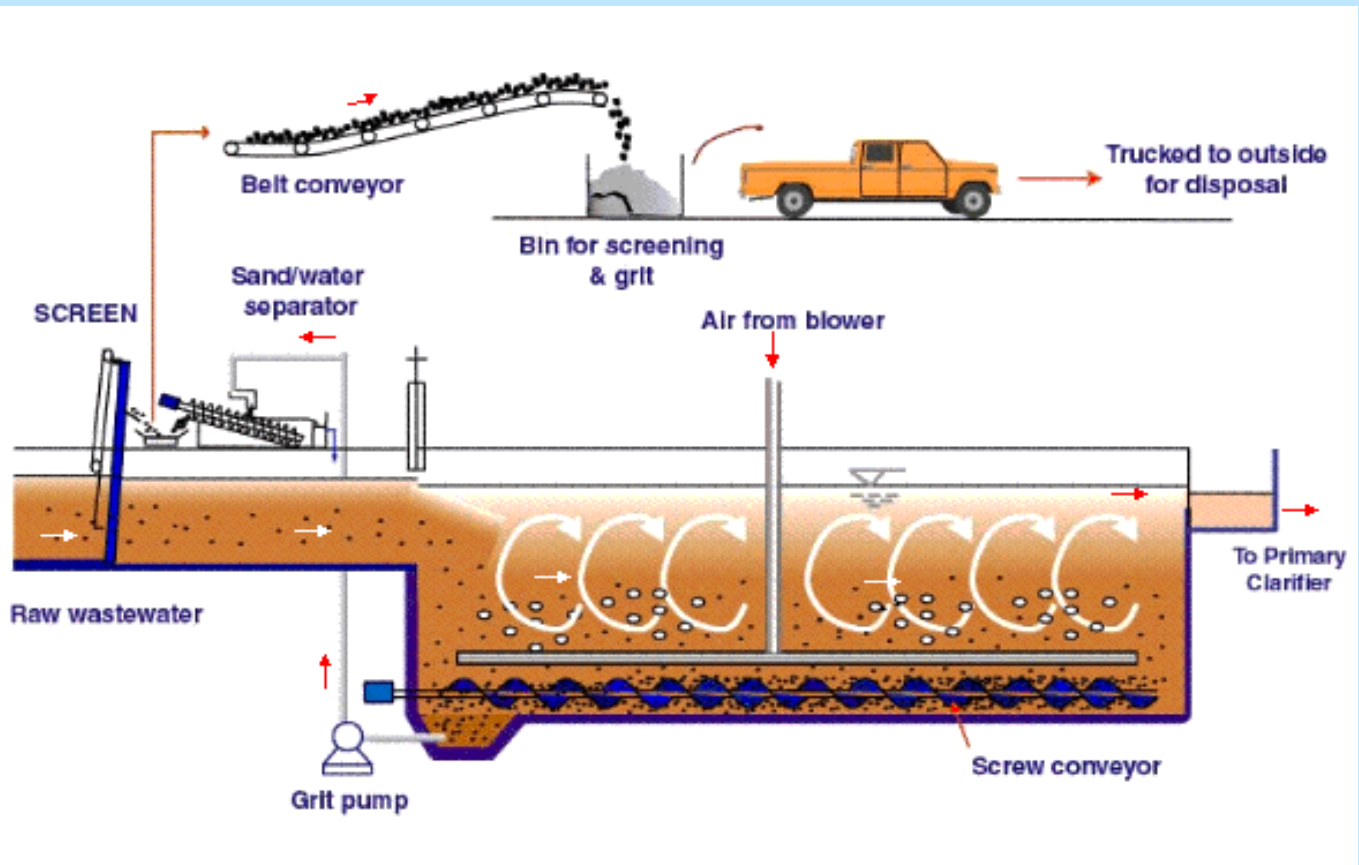
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SCHMATIC OF HEADWORKS (Screen & Aerated Grit Chamber)



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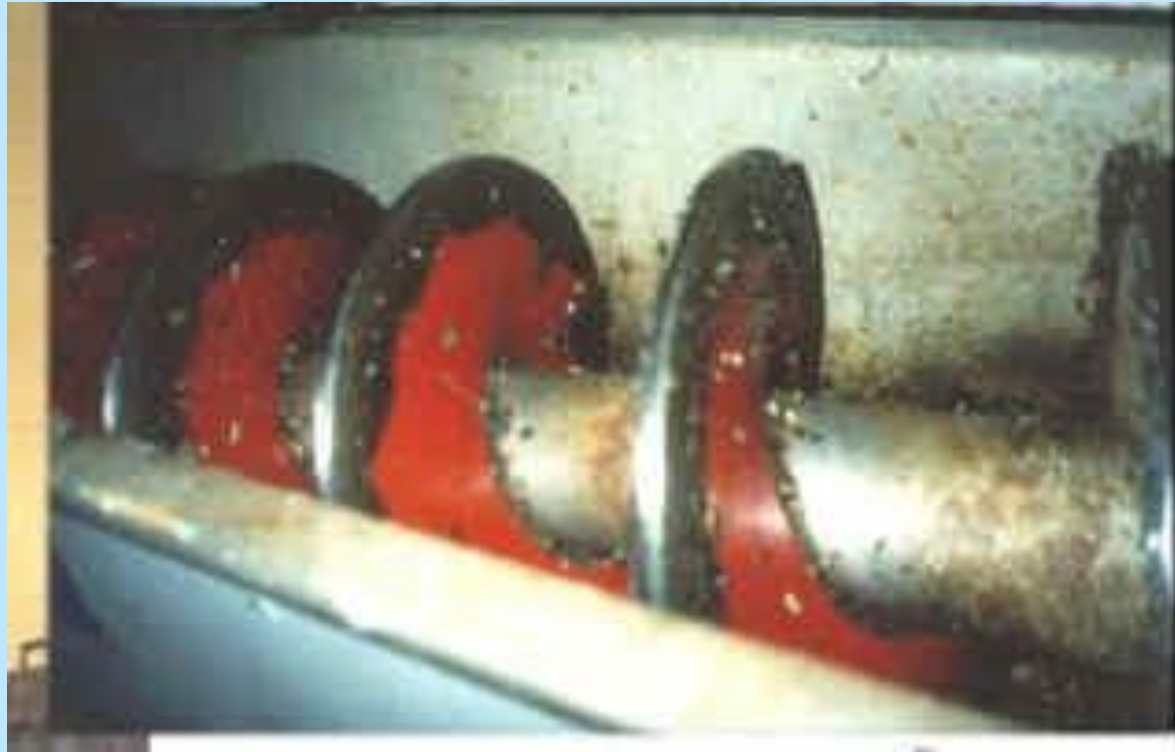
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Once settled, the grit can be removed and disposed of



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Flow Measurement

Purpose: To let you know how much wastewater you are getting...

Adjust pump, aeration, and disinfection rates, sludge withdrawal, calculation of loading rates

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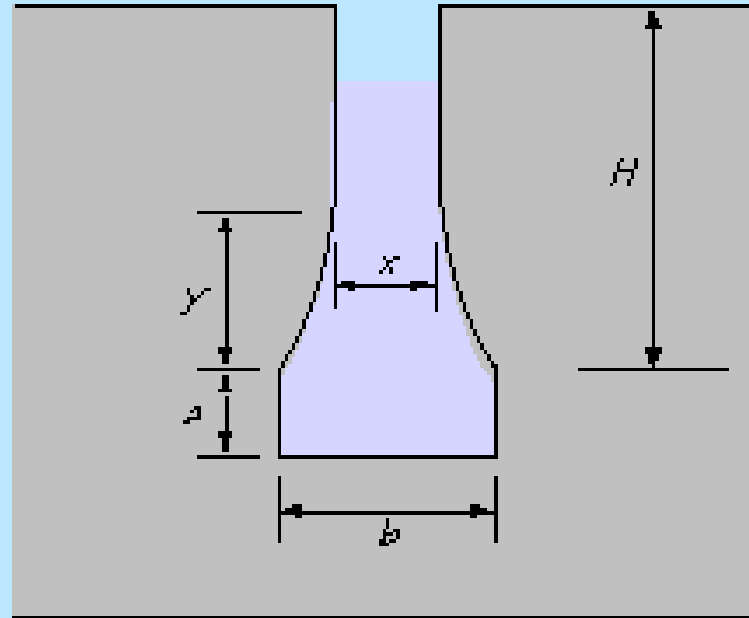
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PARSHALL FLUME



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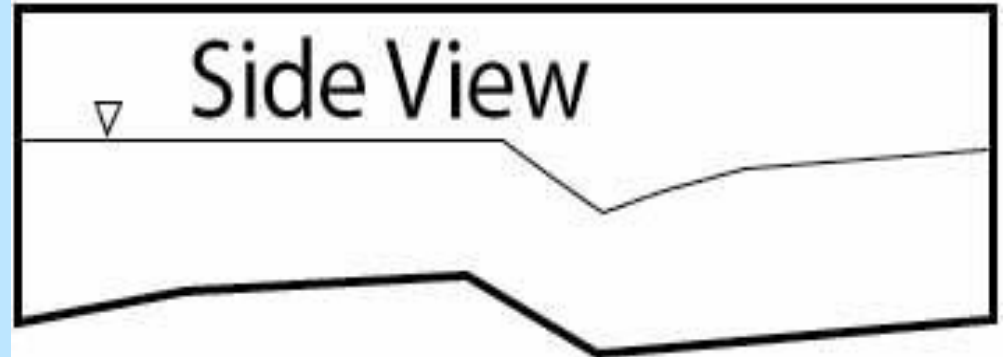
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FLOW →



Top View



Side View

PARSHALL FLUME



Other Flow Measuring Devices

WEIRS



V-notch

Rectangular

Problem with weirs is solids will begin settling upstream of weir

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Pre-aeration

- Solids settle better
- Assists in removal of grease and oils
- Removes dissolved gases
- “Freshens” wastewater

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Primary Treatment

- A “physical” process
- Flow is slowed down to allow settling
- Floatable solids can be skimmed off

Primary Treatment (con't)

- Same principle as the imhoff cone
- The settling tanks are called sedimentation tanks (or basins) or clarifiers

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Detention Time

- The time for a given flow to pass through a tank

**EXAMPLE: IF THE FLOW IS 450 gal/min
AND THE TANK SIZE IS 40,000 gal, the
DETENTION TIME IS**

$$\underline{40,000/450} = 89 \text{ min (1.5 hours)}$$

Detention Time con't

- Clarifiers are designed for 2.0 – 3.0 hours detention time

This provides:

-40%-60% Removal of Suspended Solids

-20%-50% Removal of BOD

-95%-99% Removal of Settleable Solids

-10%-15% Removal of Total Solids

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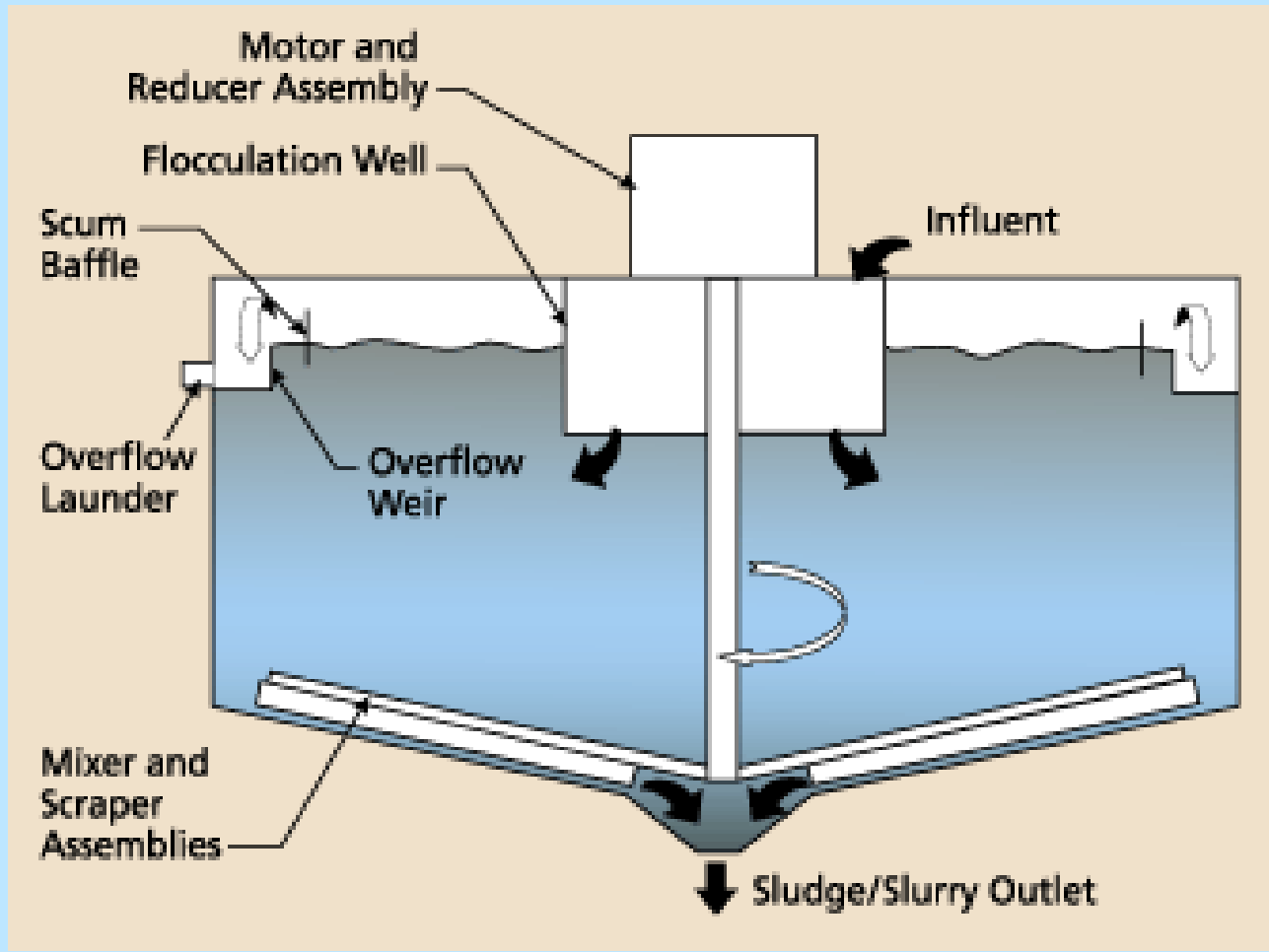
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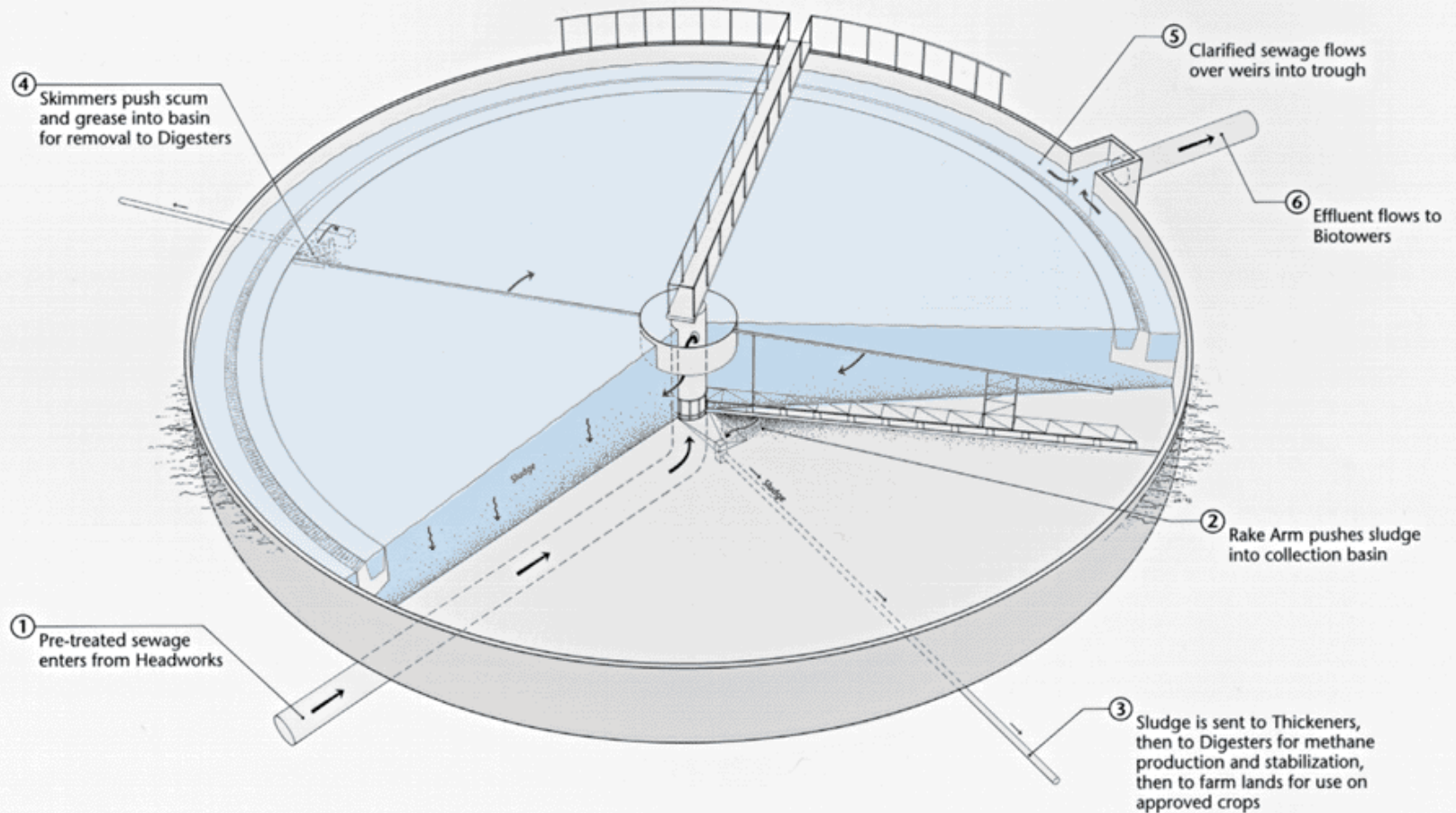
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PRIMARY CLARIFIER

Separates heavy particles (sludge) and light particles (scum) before biological treatment



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Loading Rates

Weir Overflow Rate

Primary Clarifiers – 10,000-20,000 gpd/ft.

Secondary Clarifiers – 5,000-15,000 gpd/ft.

Surface Loading Rate

Primary Clarifiers – 300-1,200 gpd/sq.ft.

Trickling Filter Clarifiers – 800-1,200
gpd/sq.ft.

Activated Sludge Clarifiers - 300-1,200
gpd/sq.ft.

Biological Treatment

- Trickling Filter
- Rotating Biological Contactor (RBC)
- Sequencing Batch Reactor (SBR)
- Activated Sludge
- Ponds












Fixed Film Processes

- Trickling filters and RBCs
- Attached Growth
- Biological secondary process
 - Removal of dissolved and finely divided organic solids
 - Conversion of soluble and colloidal material into biological film on the filter media
 - Nearly always preceded by primary clarification
 - Lightly loaded – nitrogen removal













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A TRICKLING FILTER





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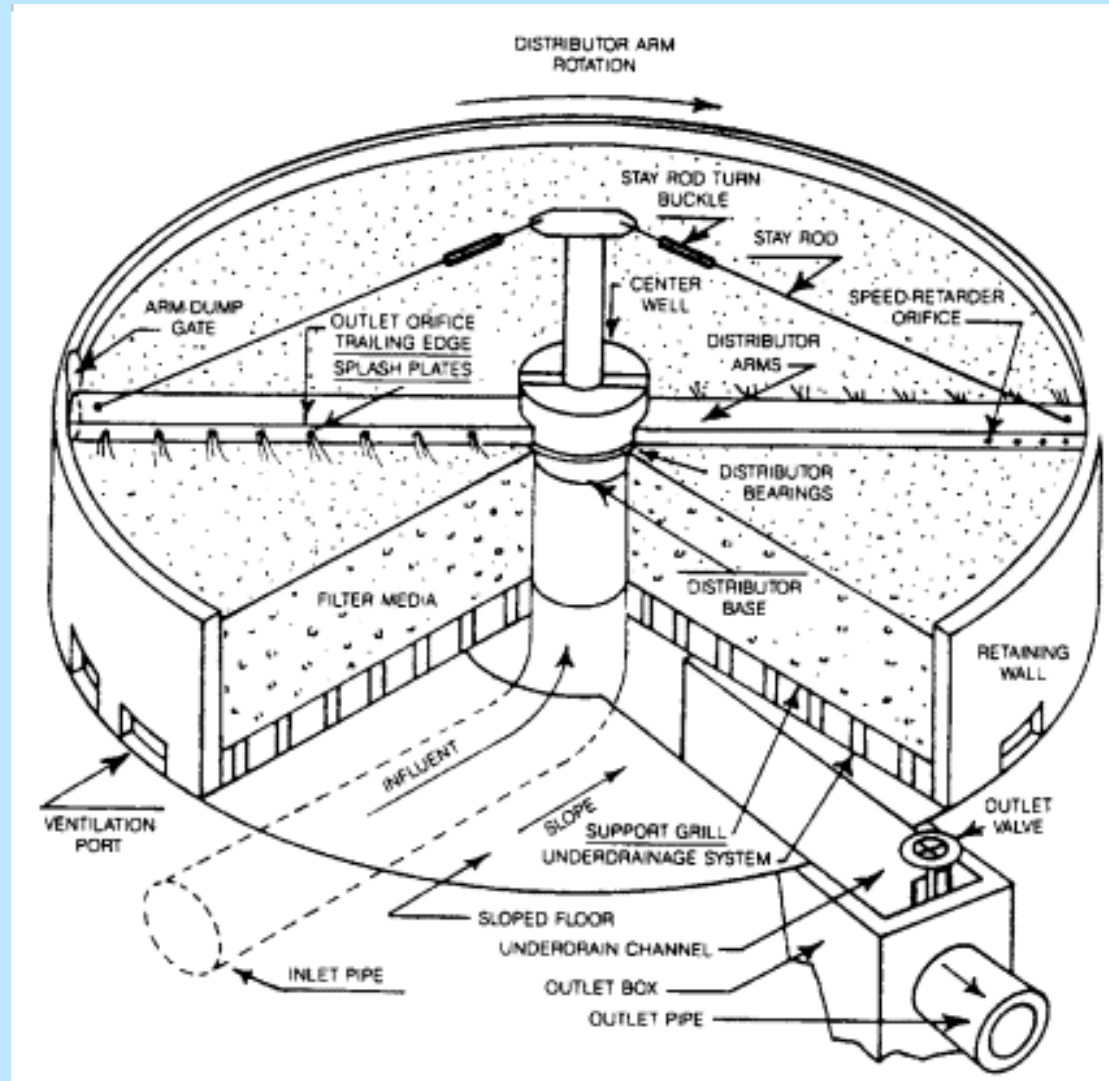
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Trickling Filters (con't)

- When biological growth on the media gets too thick, it breaks off – called sloughing
 - The sloughed material is called “humus” and requires a secondary clarifier for removal
- Process removes 70- 85% of the BOD and TSS













Rotating Biological Contactors (RBCs)

- Special discs are rotated thru the sewage and biological growth develops on the discs

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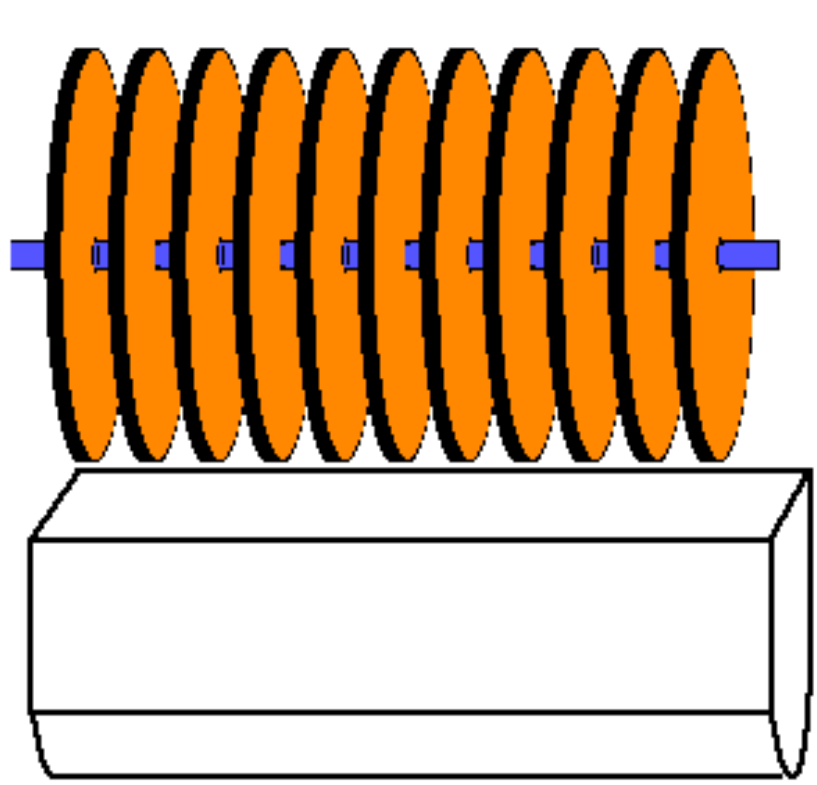
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Activated Sludge

- Consists of an aeration tank following the primary clarifier
- O₂ is supplied by diffusers or mechanical devices
- Detention time of 4 - 8 hours produce rapid aerobic growth

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Activated Sludge (con't)

- “Mixed liquor” is a mixed of raw wastewater and activated sludge

- The organisms that settle in the secondary clarifier are called “activated sludge”

- 90 - 99% removal of BOD & TSS













Secondary Clarifiers

- Solids from trickling filters, RBCs, and activated sludge must be removed before sewage is discharged
- Sludge is usually returned to the primary clarifier or the digester.

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Sludge Handling and Disposal

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- Solids sent to a large sealed tank called a digester
- After 30 days under anaerobic conditions, sludge can be dewatered, burned, or used as a soil conditioner















Sludge (con't)

- Two major types of bacteria in an anaerobic digester

1. Acid formers—produce organic acids and CO_2

2. Gas formers—break down the organic acids to produce methane (CH_4)

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Sludge (con't)

- The CH_4 gas heats the digester (95°F) & runs engines
- The liquid above the settled solids is called “supernatant”
- Digesters can be very dangerous if air becomes mixed with the methane

Sludge (con't)

Some activated sludge plants use aerobic digesters

- These are open tanks where compressed air is blown thru the sludge



Waste Treatment Ponds

Also called: stabilization ponds, oxidation ponds, bio-oxidation ponds, sewage lagoons...

- Aerobic ponds: 3 – 6 feet deep
- Anaerobic: 8-12 feet deep












Ponds (con't)

- Ponds that are aerobic on top and anaerobic on bottom are called “facultative ponds” (most common)

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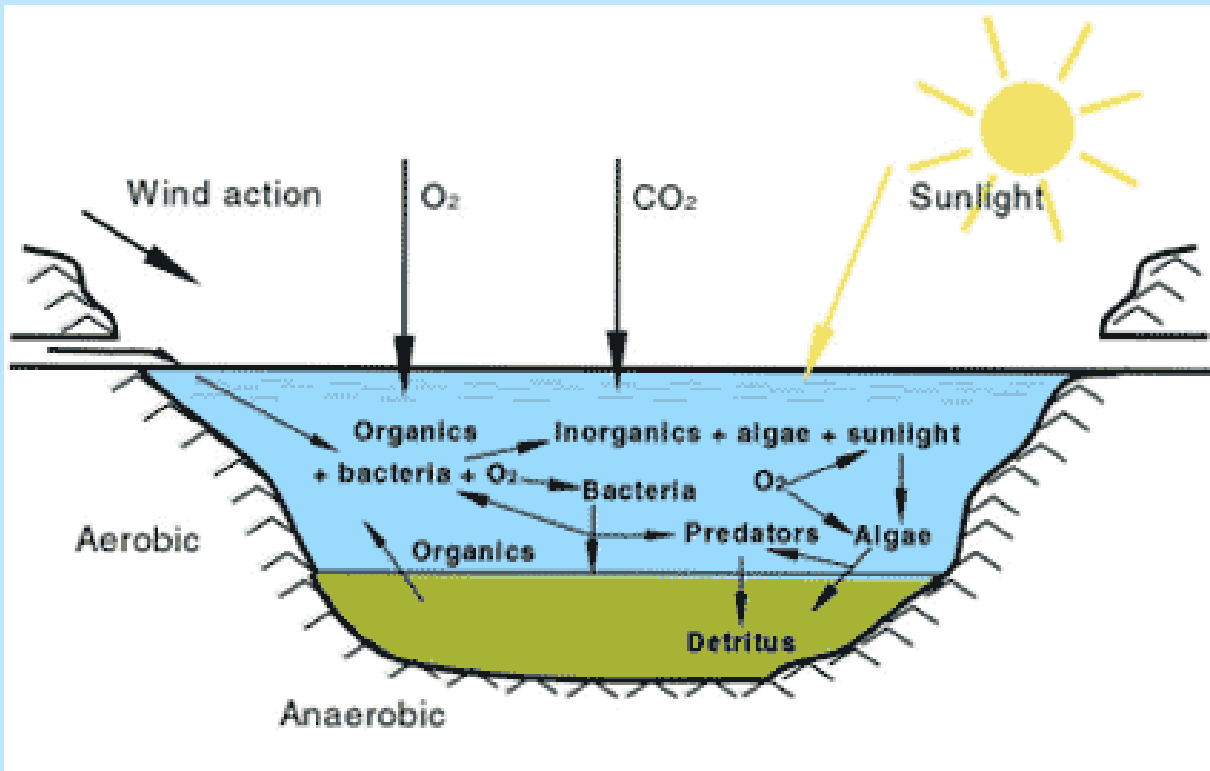
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How Do Ponds Work?

- Wastewater enters the pond
- Settleable solids decompose and use O_2
- Organisms use the oxygen and produce CO_2 which causes algae to grow
- Through photosynthesis the algae utilize CO_2 to produce oxygen (O_2)
- Organisms use the oxygen to stabilize the wastewater



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Ponds (con't)

- Ponds can be operated in series or in parallel
- Have a detention time of 30 days or more
- “Oxidation Ponds” follow primary treatment
- “Waste Stabilization Ponds” receive untreated waste

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Disinfection

- Must kill remaining pathogens
- Chlorine gas (Cl_2) is the most used disinfectant
- Must have 20-30 minutes of “contact time”

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Disinfection (con't)

- Some effluents must be “dechlorinated” with sulfur dioxide (SO₂)
- Chlorine can be dangerous
- Some plants use ultraviolet light and other disinfectants