Primary Treatment

Sedimentation and Flotation

New Mexico Rural Water Association

Revised 2012

Primary Treatment

Physically removes those materials that will **float** or **settle** in 2 - 3 hours

- Settling tank
- Sedimentation tank
- Clarifier

Names for the same

Usually located

After grit removal and **before** biological treatment

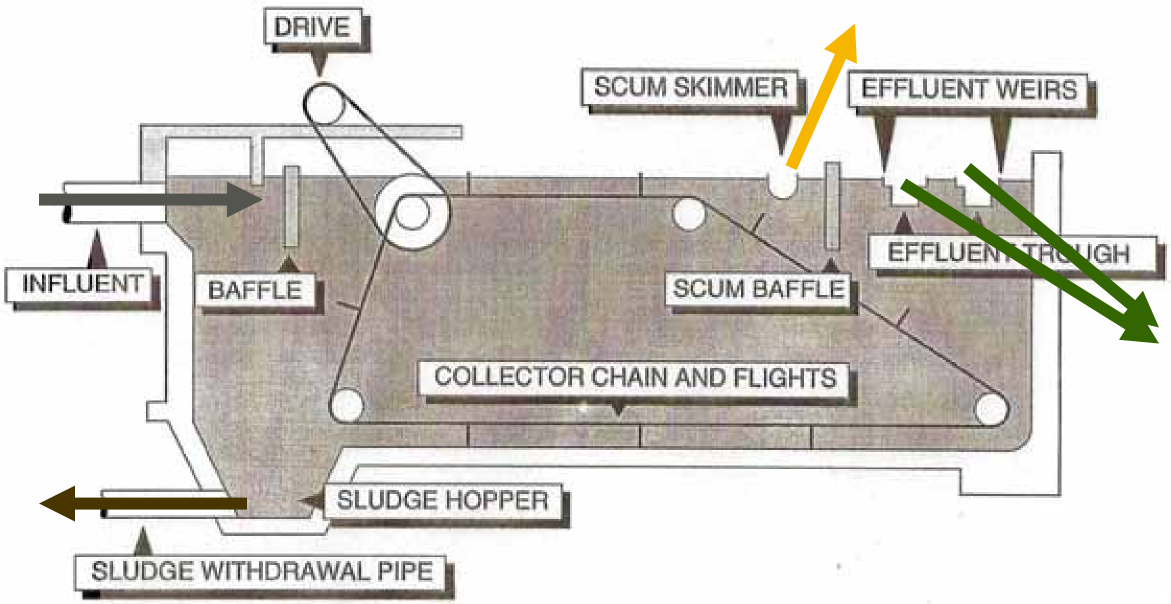
- Secondary clarifiers are located **following biological treatment** and are considered part of the secondary treatment phase

- The main difference in Primary and Secondary clarifiers is the **density of the sludge** generated

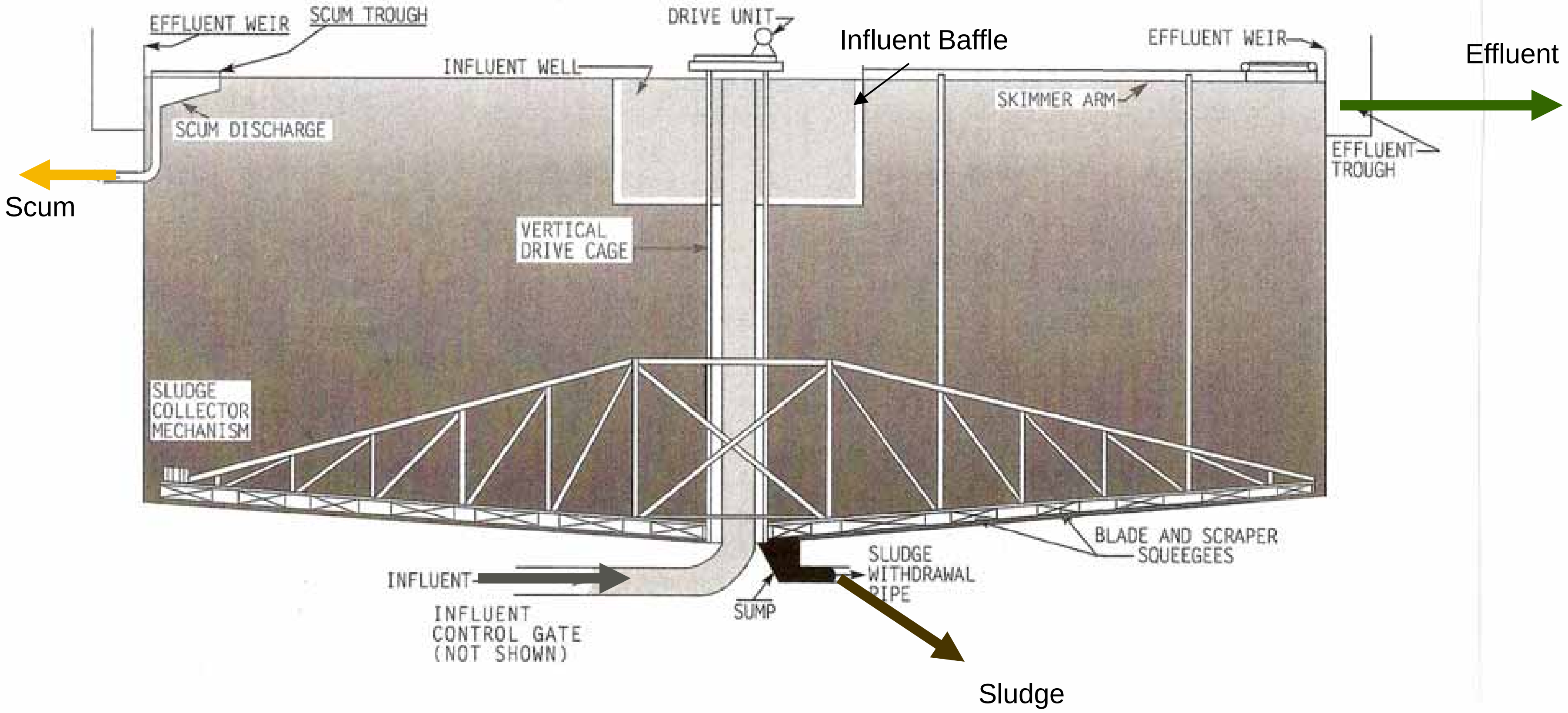
- **Primary sludges are denser**

- Also, Secondary clarifiers produce clearer effluents

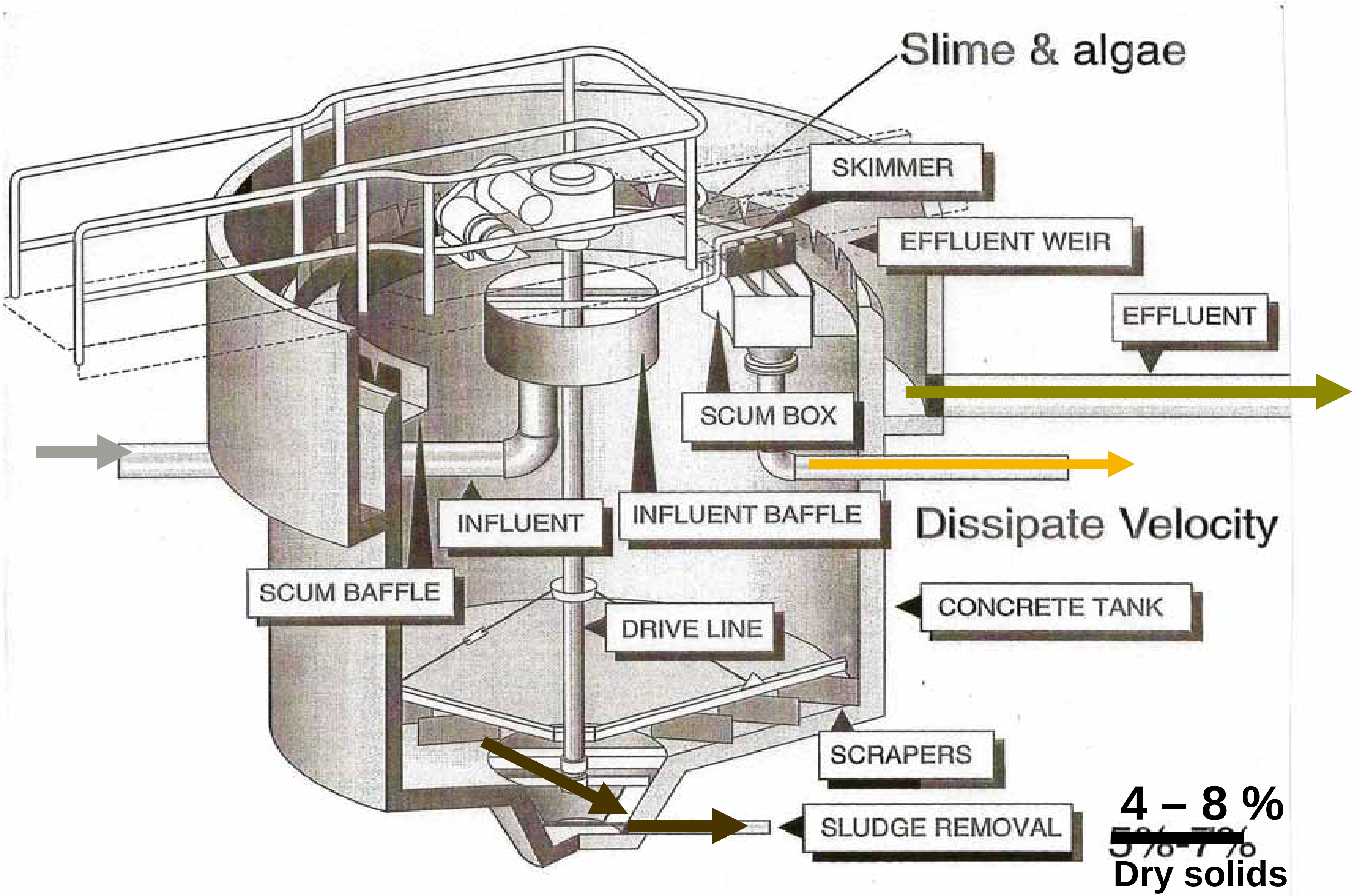
Rectangular Clarifier



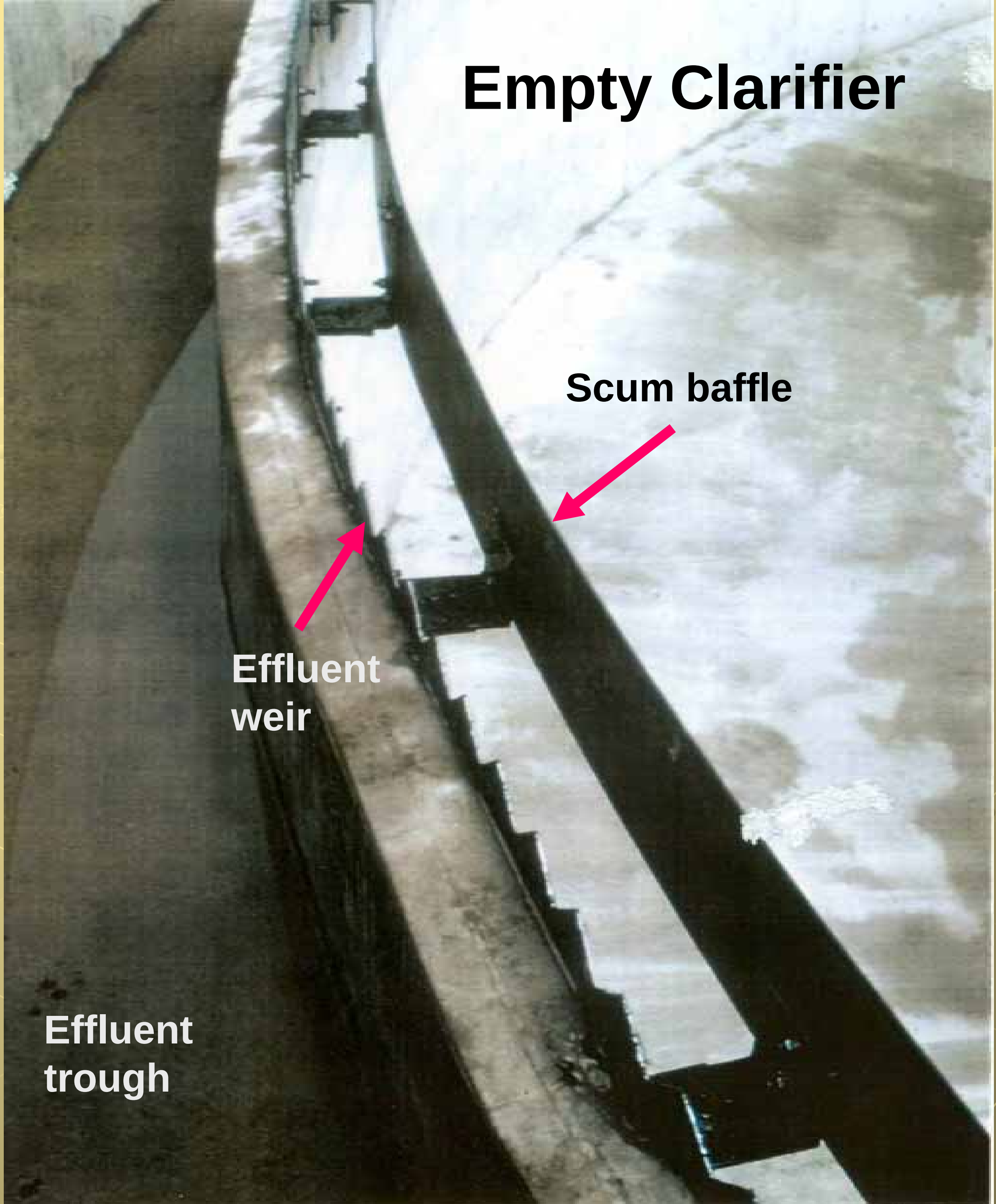
Round Clarifier



Round Clarifier



Empty Clarifier




Round Clarifier
Yes, these are made from culvert.

Calculation of Primary Clarifier Efficiencies

$$\text{Efficiency \% (Removal)} = \frac{(\text{IN} - \text{OUT})}{\text{IN}} (100\%)$$

Influent (IN) BOD = 200 mg/l

Effluent (OUT) BOD = 120 mg/l

Calculate how well this clarifier removes BOD

Answer

$$\text{Efficiency \%} = \frac{(IN - OUT)}{IN}(100\%)$$

$$\% = \frac{(200 - 120)}{200}(100\%)$$

$$\% = \frac{(80)}{200}(100\%)$$

$$\% = (0.4)(100\%)$$

Efficiency % = 40% BOD removal

Typical Clarifier Efficiencies

Parameter	Expected Removal
BOD	20% - 50%
TSS	40% - 60%
Settleable Solids	95% - 99%
Total Solids	10% - 15%
Bacteria	25% - 75%

Sludge & Scum Pumping

- Remove sludge at frequent intervals
- Sludge septicity indicators
  - Gassing
  - Floating clumps
- Pump as thick a sludge as possible
  - 4 – 8% Total Dry Solids
- Withdrawal rates should be ***slow*** to prevent coning

Conditions Affecting Sludge Concentration

- Specific gravity   [p.E-25 in Study Guide]
- Size and shape of particles
- Temperature
- Turbulence in tank

Specific Gravity

- The ratio of a liquids' density to that of water
  - Density of molasses is 93.6 lbs/cu ft
  - Density of water is 62.4 lbs/cu ft

- Specific Gravity of molasses is **1.5**

$$\frac{93.6}{62.4} = 1.5 \text{ (no units)}$$

Factors Influencing Settling Characteristics

- Temperature
- Short circuits
- Detention time
- Weir overflow rate
- Surface loading rate
- Solids loading

Pretty dry stuff

Temperature

IN GENERAL

As water temperature **increases,** settling rate of particles **increases**

As water temperature **decreases**, settling rate of particles **decreases**

Short Circuits

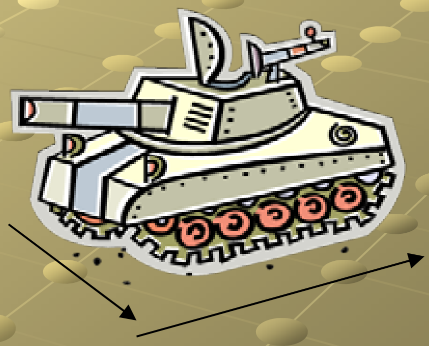
- Water entering should be evenly dispersed across the entire cross-section of tank
- Water should flow at the same velocity toward the discharge end of the tank

Baffles, weirs, port openings and proper design of inlet channels are key

Detention Time

Need to know

- Flow in gpd
- Tank dimensions or volume



Usual detention time design is

2 – 3 hours

Weir Overflow Rate

- Number of gallons that flow over 1 linear foot of weir per day
- Generally design for 10,000-20,000 gal/ day per lineal foot for Primary Treatment
- Lower weir overflow rates for Secondary clarifiers

Surface Loading Rate

- GPD/sq ft of tank surface area
- 300 -1,200 GPD/sq ft typical range

- Low rates for small plants in cold climates
- High rates for warm regions to avoid septic conditions

- Important for settleable solids removal efficiency

Solids Loading

- Indicates the amount of solids removed daily for each sq ft of clarifier liquid surface area
- Expressed in lbs/day/sq ft
- Need to know
  - Flow in MGD
  - TSS in mg/l
  - Liquid surface area in sq ft

Imhoff-Type Tanks

- Combined sedimentation-digestion tanks

- Top compartment is for settling/flotation
- Bottom chamber is for anaerobic digestion

- Round units - Clarigester
- Rectangular units - Imhoff Tanks

Typical Values

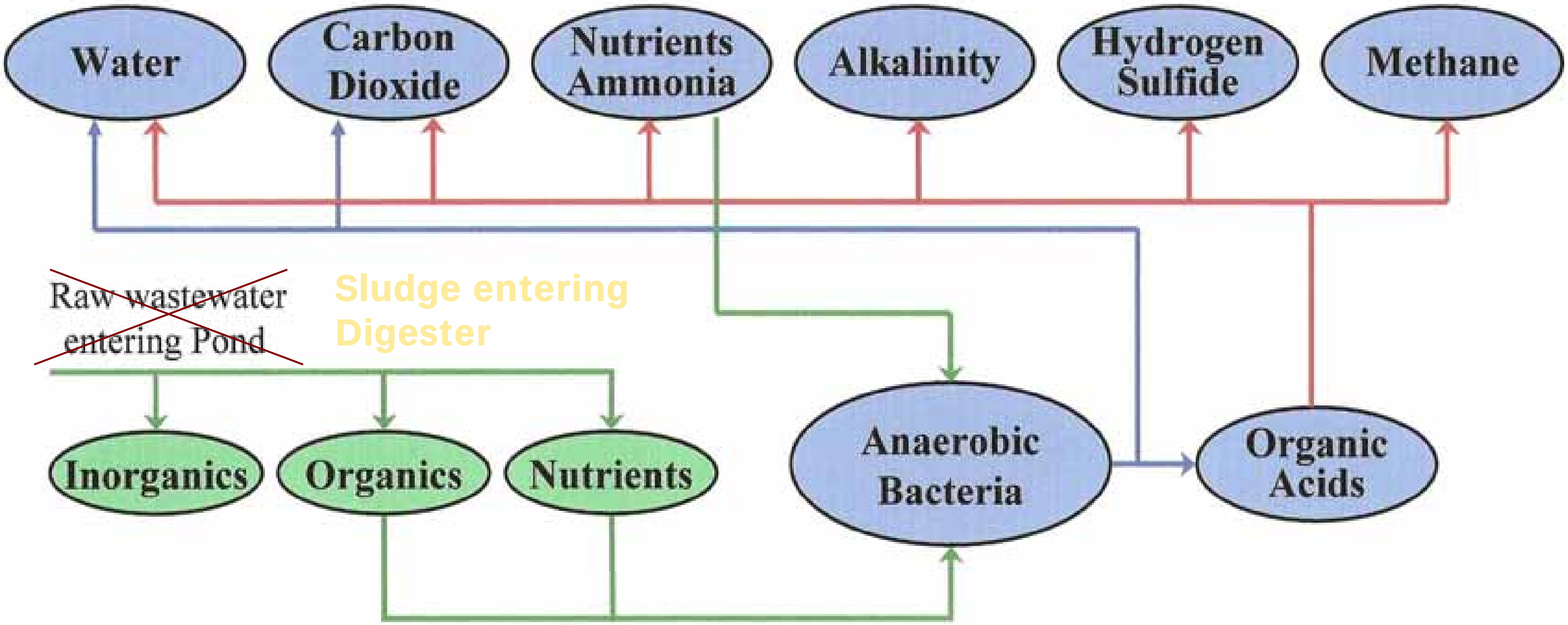
- **Clarification Tank** (Upper chamber)

Detention time	1 – 4 hours
Surface loading rate	600-1,200 GPD/sq ft
Weir overflow rate	10,000-20,000 GPD/lineal ft
BOD removal	25% - 35%
TSS removal	45% - 65%

Typical Values cont’

- **Digestion Tank** (Lower chamber)
  - Digestion capacity 1 – 3 cu ft/person
  - Sludge storage 3 – 12 months

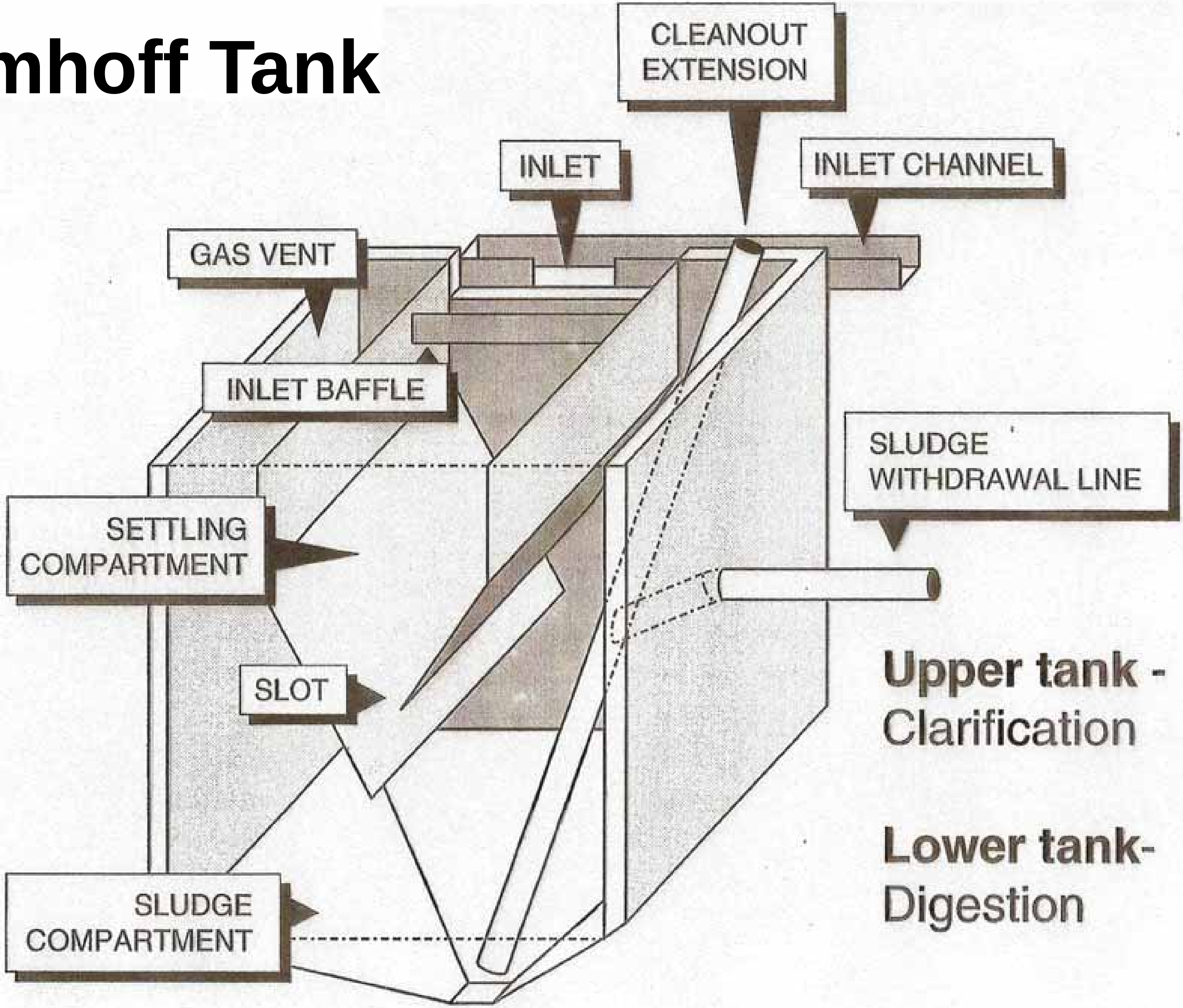
Anaerobic Process



Acid producing bacteria convert organic matter to volatile acids, carbon dioxide, water, and nitrogen.

Methane fermenting bacteria break down acids and other products to methane gas, carbon dioxide, hydrogen sulfide, alkalinity, and water.

Imhoff Tank



Upper tank - Clarification

Lower tank- Digestion

IMHOFF TANK MAINTENANCE

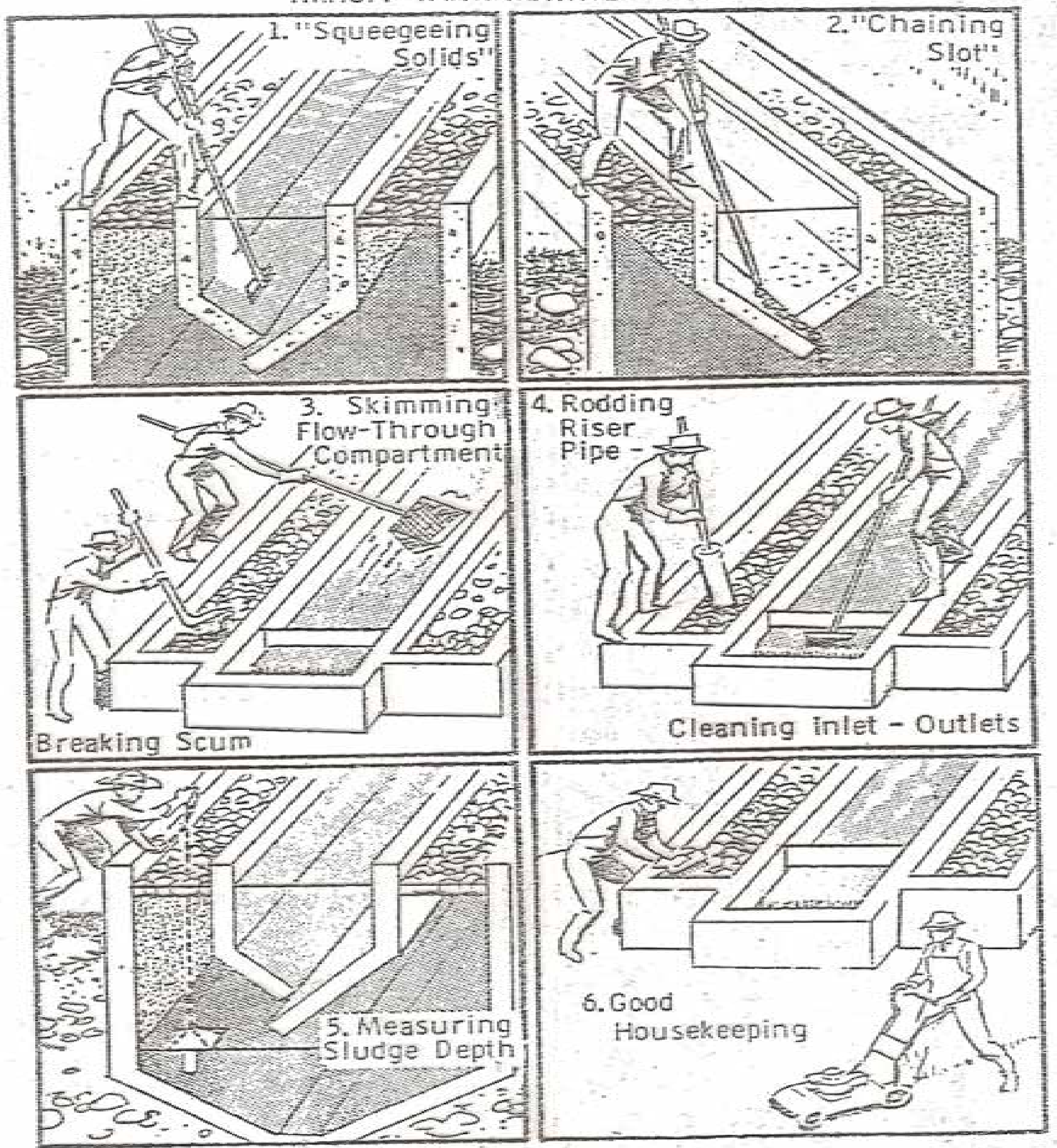
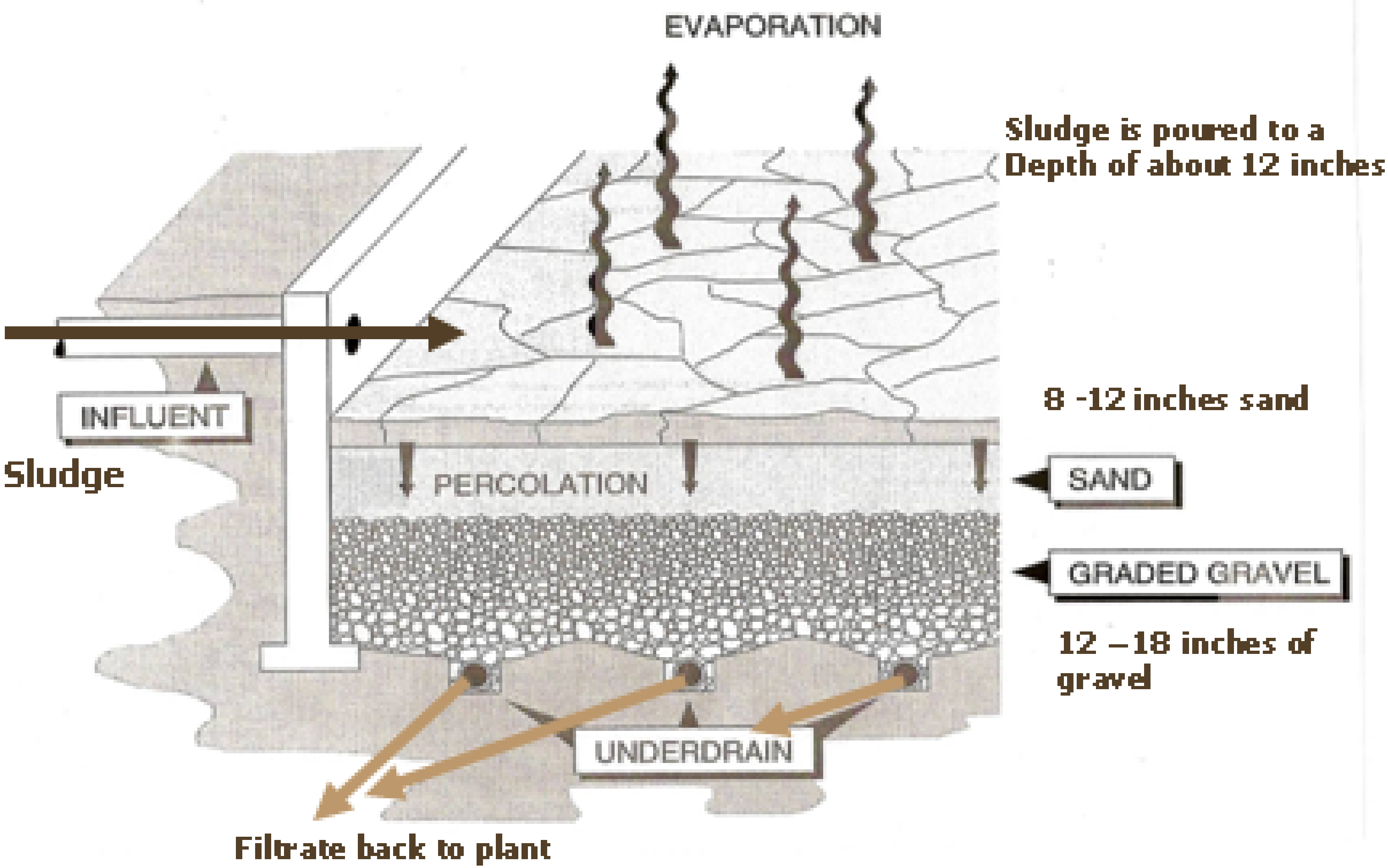


FIG. 10-4. Imhoff Tank Maintenance Procedures (Safety Features Omitted for the Purposes of Clarity).

Sludge Drying Beds

- Sand Drying Beds
  - Can dry to > 95 % Total Solids
  - Typical 70 – 80 % Total Solids
- Asphalt/Concrete Drying Beds
- Vacuum Filter Beds

SAND DRYING BEDS



Asphalt/Concrete Drying Beds

- Similar to sand drying beds
- Have hard asphalt or concrete surface
- Sludge can be poured to depth 18 – 30 inches
- Mixing equipment assists in quick drying
- Using tractor, backhoe, “Brown Bear”
- Decant tubes to remove water

Vacuum Filter Beds

- Shallow concrete basin with underdrains
- Covered with one of the following
  - Porous pumice bricks
  - Stainless steel perforated panels
  - Plastic perforated panels
- Polymer-conditioned sludge is poured
- Vacuum applied under panels to draw water to drains
- Sludge dewatered to 15 – 30 % TS in a few hours to a few days

EVEN MORE TOILET HISTORY

The pollution in the River Thames caused by sewage became particularly bad in the Victorian Era. In 1858 "The Great Stink" from the Thames caused Parliament to close down.

London's first proper drainage system,with eighty-three miles of large intercepting sewers, opened in 1865.