WASTEWATER TREATMENT

By: Engr. Abdul Mannan Zafar

WASTEWATER TREATMENT

It is the processing of wastewater to remove pollutants/contaminants to levels that are not harmful to environmental & human health.

OBJECTIVES OF SEWAGE TREATMENT

1. To protect Human Health:

- Pathogens, heavy metals, and other toxic constituents of wastewater are of public health concern.

2. To protect health of environment:

If untreated wastewater is disposed into environment, then following effects can be occurred;

- Depletion of Oxygen resources of stream
- Eutrophication, turbidity, taste and color in water bodies
- Toxic for aquatic life
- Soil pollution (in case of land disposal)

OBJECTIVES OF SEWAGE TREATMENT

3. For wastewater Reuse Applications:

Treated wastewater may be used for one of the following:

- Irrigation purposes
- Industrial purposes
- Ground water recharge

4. To fulfill legal requirements:

- Pak EPA effluent standards (BOD ≤ 80 mg/L)

Wastewater Treatment Methods:

- Physical Unit Operations,
- Chemical Unit Processes,
- Biological Unit Processes.

Degree and Type of Treatment:

- The degree of sewage treatment depends upon the strength of wastewater (i.e. characteristics), the method of wastewater disposal or reuse.

Levels of Wastewater Treatment

1. Preliminary Treatment
2. Primary Treatment
3. Secondary Treatment
4. Tertiary/Advanced Treatment

1. Preliminary Treatment:

Purpose; Removal of large floating particles and grit (heavy inorganic particles of silt, clay etc) which interfere with mechanical equipments of subsequent treatment units.

Units employed; Screens and Grit chamber

Levels of Wastewater Treatment

2.Primary Treatment:

Purpose: Removal of suspended (settle-able) organic matter.

Unit employed: Primary sedimentation tanks

BOD removal = 15-30%, S.S. removal = 30-60%

3. Secondary Treatment:

Purpose; Removal of soluble and colloidal organic matter that remains after primary treatment.

Methods used; It is generally achieved by biological treatment processes like Activated Sludge Process (ASP), Trickling Filters (T.F), Aerated Lagoons (A.L),Wastewater Stabilization Ponds (WSPs) etc.

BOD removal = 75-95% , S.S. removal = 90 %

Levels of Wastewater Treatment

4.Tertiary/Advanced Treatment:

Purpose: Removes specific residual substances, trace organic materials, nutrients, and other constituents that are not removed at primary and secondary levels of treatment.

Methods Used: Physical, chemical, biological or a combination of these methods are used.

Levels of Wastewater Treatment

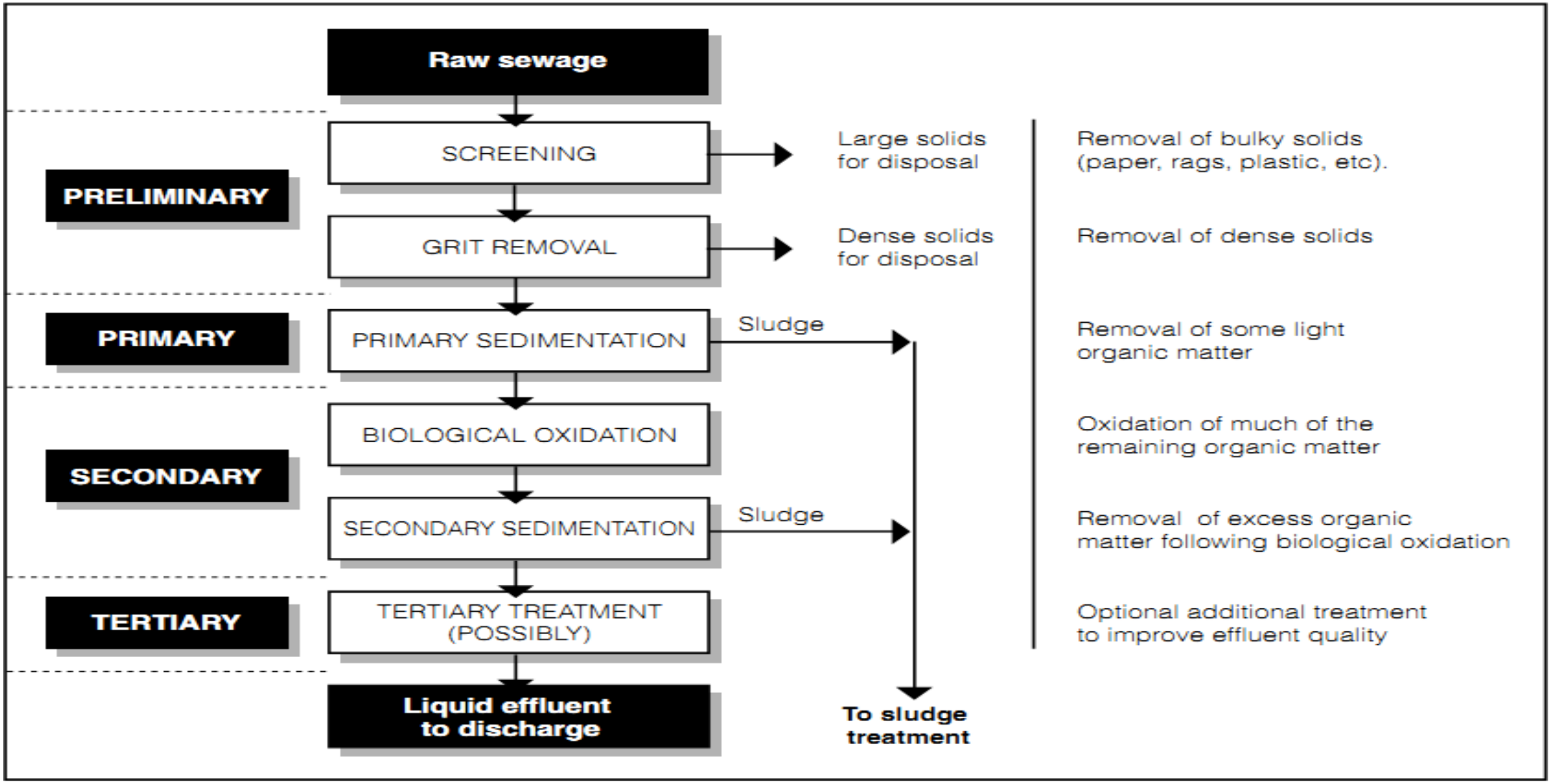
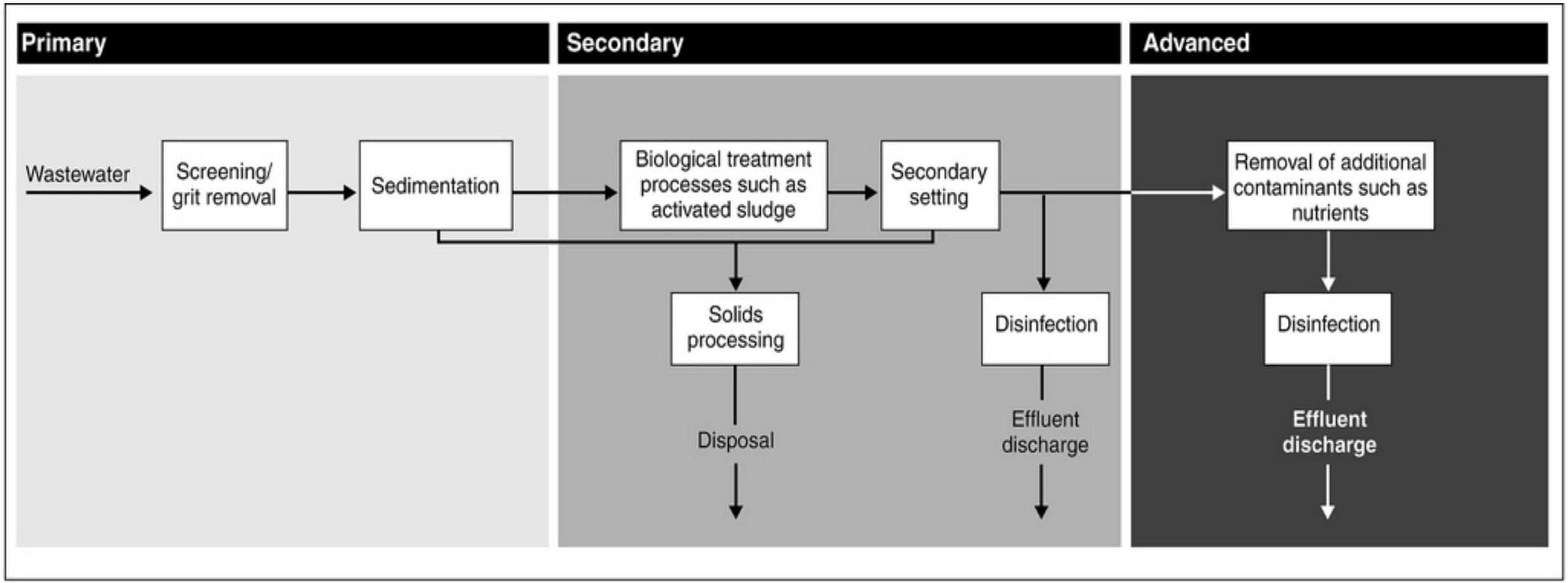


Figure 1. Typical stages in the conventional treatment of sewage

Levels of Wastewater Treatment



Source: GAO analysis.

PRELIMINARY TREATMENT

1. SCREENS:

- Screens remove large suspended solids such as rags, sticks, plastics and similar materials from the wastewater.
- The bar screen may be coarse (2-4 inch openings) or fine(0.75-2.0 inch openings).
- The bar screen may be manually cleaned or mechanically cleaned.
- Typical amount of screenings = 1.5×10^{-5} m^3/m^3 of sewage.
- Screenings are to be disposed off either by landfill or incineration.

SCREENS:

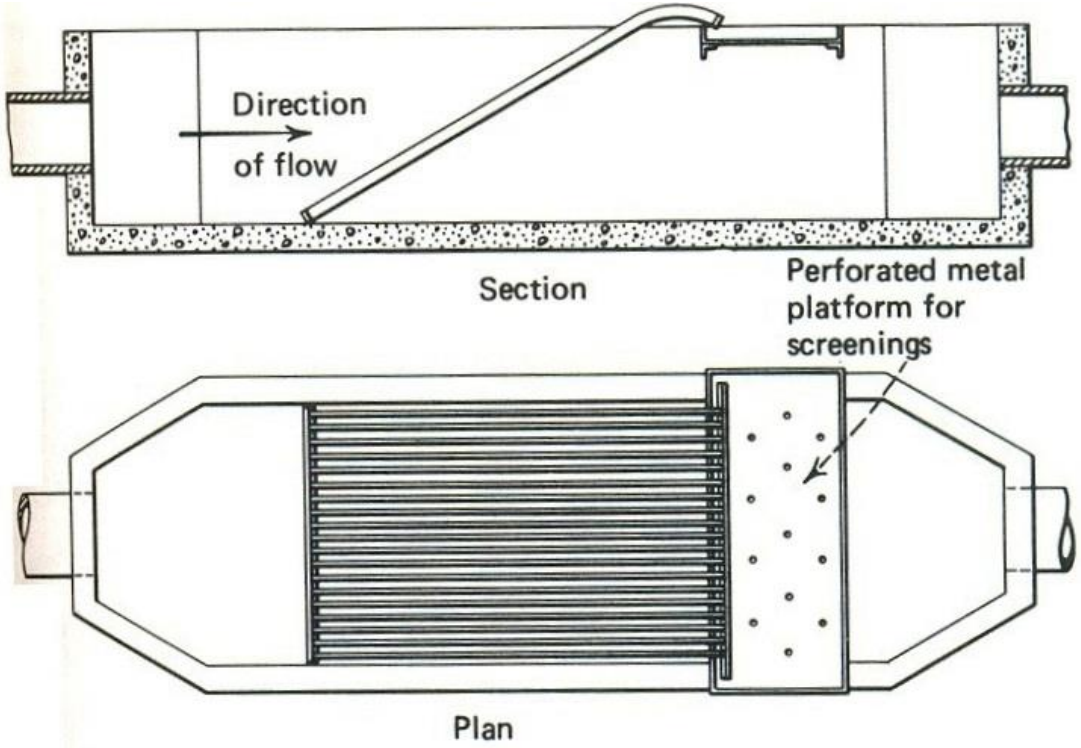


FIGURE 20-1
Manually cleaned bar screen.

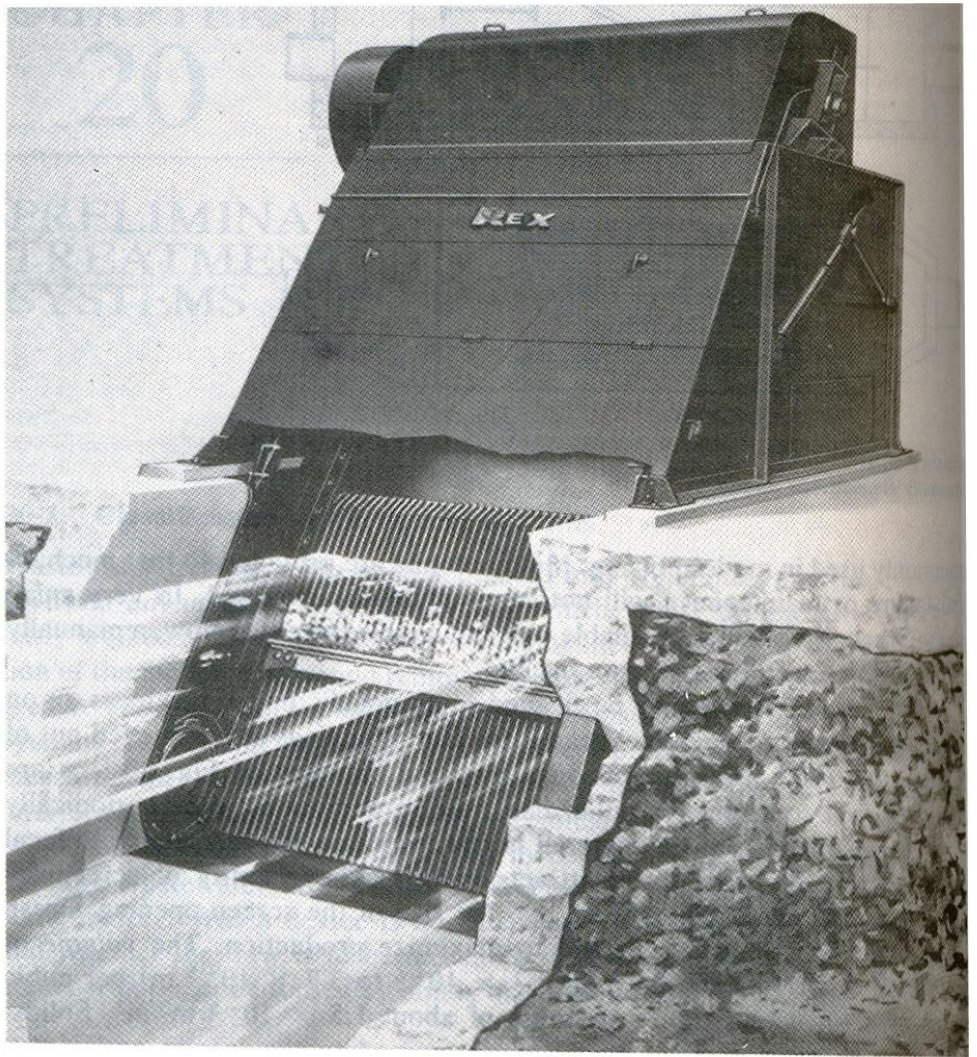


FIGURE 20-2
Mechanically cleaned bar screen *(Courtesy Envirex, a Rexnord Company.)*

PRELIMINARY TREATMENT

1. SCREENS:

Design Guidelines:

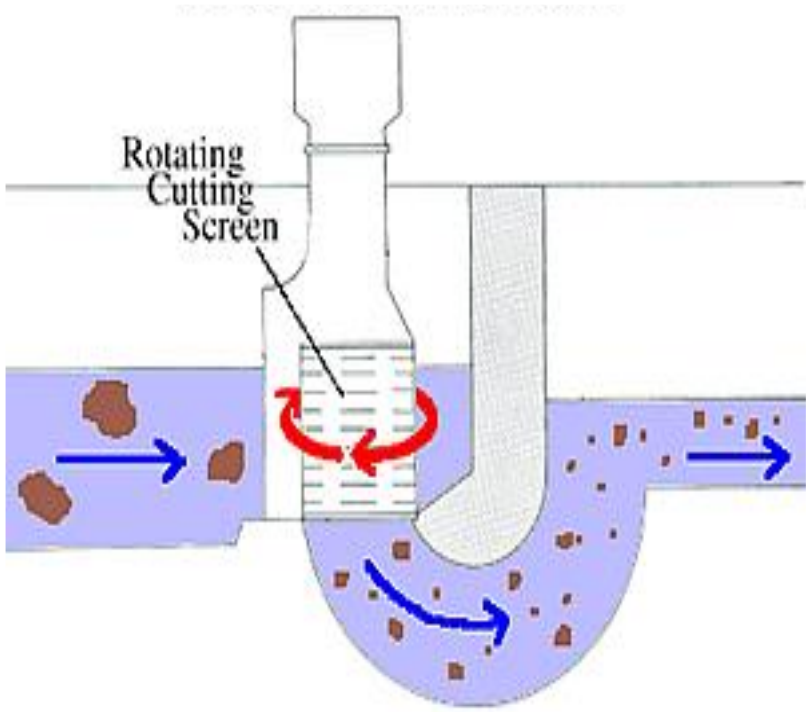
- Use 2 BAR RACKS at least, each designed to carry peak sewage flow.
- Maximum allowable head loss is 15 cm.
- Velocity through the screens should be around 1.5 fps (0.45 m/s).
- If the velocity of flow decreases below 1 fps (0.3 m/s) or slower, grit will drop out of the flow and deposit in screening chamber.

PRELIMINARY TREATMENT

2.COMMINUTOR

- In some plants, shredding devices such as comminutor are installed as alternatives to screens.
- Comminutor reduce solids to a size that can enter the plant without causing mechanical problems or clogging.
- Chopped solids are then removed from the flow in subsequent sedimentation process.

COMMINUTOR



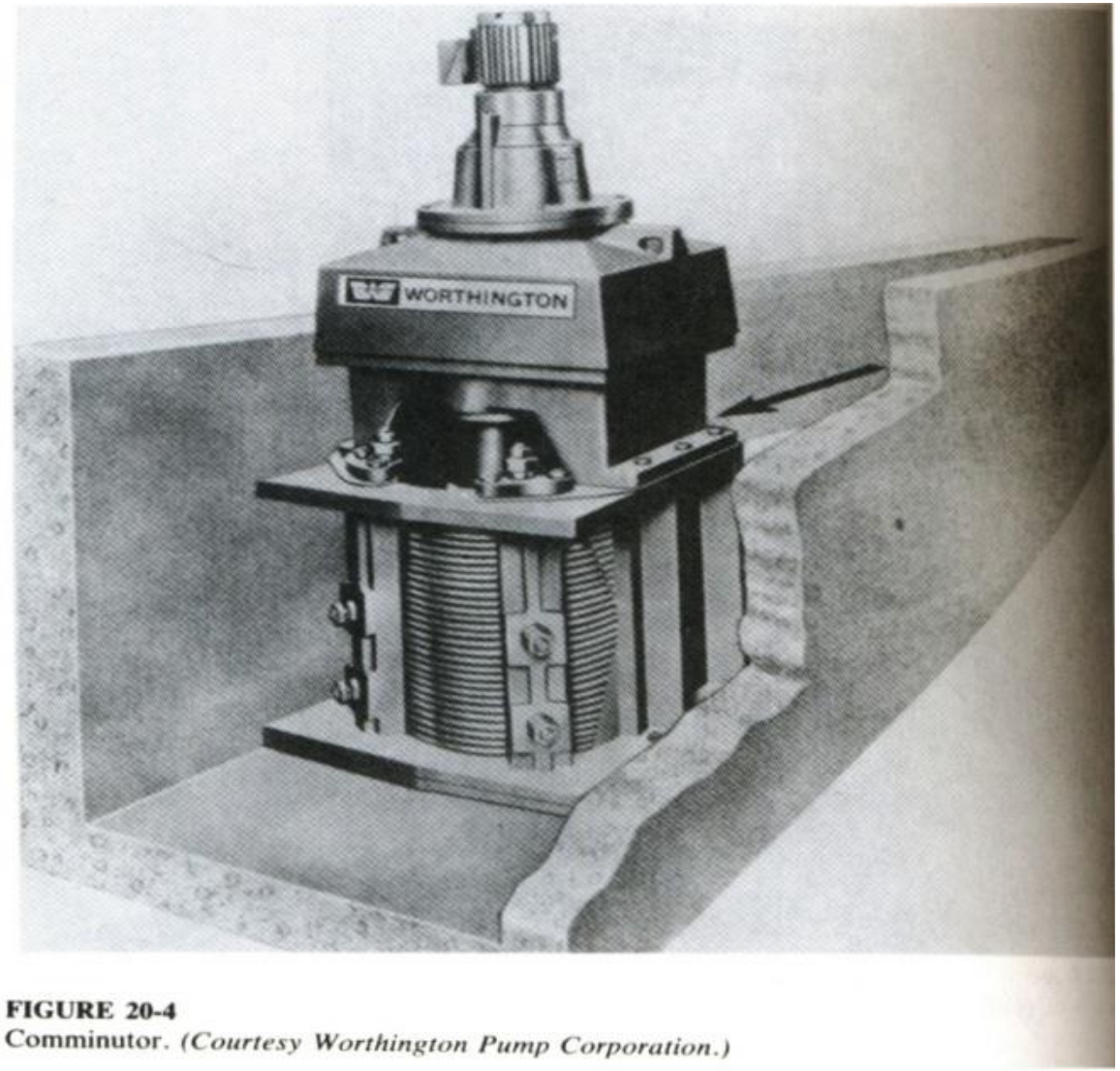


FIGURE 20-4
Comminutor. *(Courtesy Worthington Pump Corporation.)*

PRELIMINARY TREATMENT

3. GRIT CHAMBER

- **GRIT** includes sand, clay, egg shells, metal fragments and other similar materials.
- Grit, if not removed, can cause following problems;

1. It damages the pumps and other mechanical equipments of treatment units.
2. It may accumulate in primary sedimentation tank and clog the sludge lines.
3. Cause serious troubles in sludge digestion and is not benefited by secondary treatment.

PRELIMINARY TREATMENT

Design Basis:

- Grit removal devices rely on the difference in specific gravity between organic and inorganic solids to effect their separation.
- Generally are designed to remove grit particles of size larger than 0.2 mm.
- All particles settles with the settling velocity

$$Vs = \left[\frac{4g(\rho_s - \rho)d}{3C_D\rho}\right]^{0.5}$$

$$C_D = \frac{24}{R}$$

$$R = \frac{vd\rho}{\mu}$$

- Where; C_D = Drag Coefficient and u = fluid viscosity
- If the case in most settling in wastewater treatment, the Reynolds number (R), is sufficiently low and a laminar boundary layer is maintained then Cd can be expressed as:
- Scoured at a velocity

$$V_H = \left[\frac{8\beta(S_s - 1)gd}{f}\right]^{0.5}$$

- To ensure removal of grit while permitting the organic matter which may settle, to be re suspended by scour, the horizontal velocity should be close to but less than the scour velocity of the grit.

GRIT CHAMBER

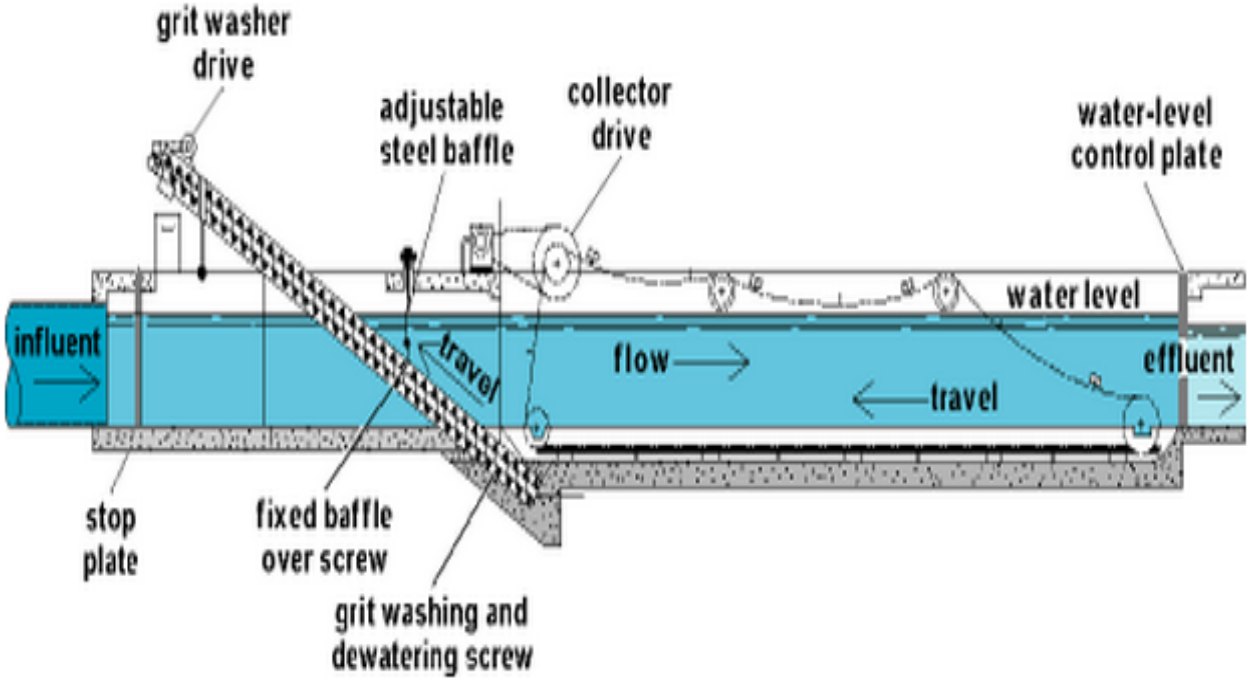


Fig. Diagram showing components of a grit chamber.

Design Guidelines

Parameters	Values
Velocity	0.25-0.30 m/s
Detention time	40-60 s
Length	10-20 m
Cleaning interval	2 weeks
Data required	Q_{max}
Unit No.	2
W:D	1:1 to 5:1
L:W	3:1 to 5:1

Problem 1 (Design of Grit Chamber)

A suspension contains particles of grit with a dia of 0.2mm and specific gravity of 2.65.For Particles of this size , C_D =10 , b= 0.06 , and f =0.03 .The suspension also contains organic solids of same size for which the specific gravity is 1.10 and f, b are unchanged.
Determine the settling velocity of the grit and scour velocity of both grit and organic material.
Select a horizontal velocity for the basin.

Problem 2

Design an grit chamber for the treatment of municipal wastewater .the average flow rate is 0.5 m^3/s, and the peaking factor of 2.75,B=0.06,f=0.03,CD=10.

Problem 3

Design a grit chamber to remove a grit of size greater than 0.2 mm if the flow is 10,000 m^3/d. The specific gravity of the particles is 1.9 and settles with the settling velocity of 0.02m/s