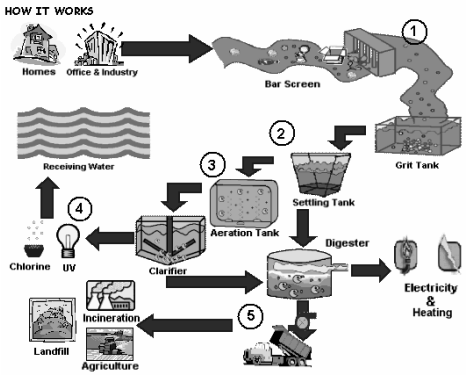
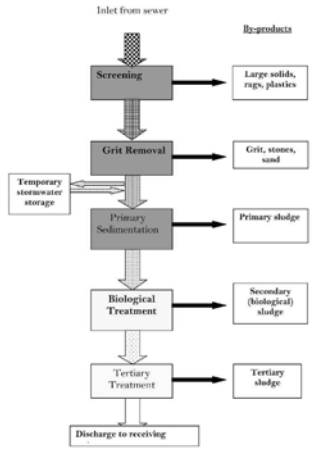
CE 370

Grit Removal

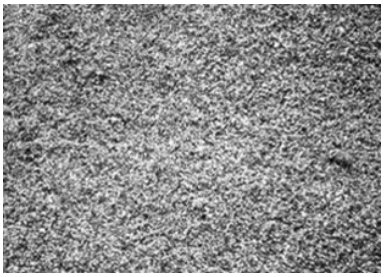
Wastewater Treatment Plant





What Is Grit

- Sand and silt particles (mostly)
- Cinders
- Fragments of egg shells
- Bone chips
- Coffee grounds
- Shredded garbage



Where Is It Used ?

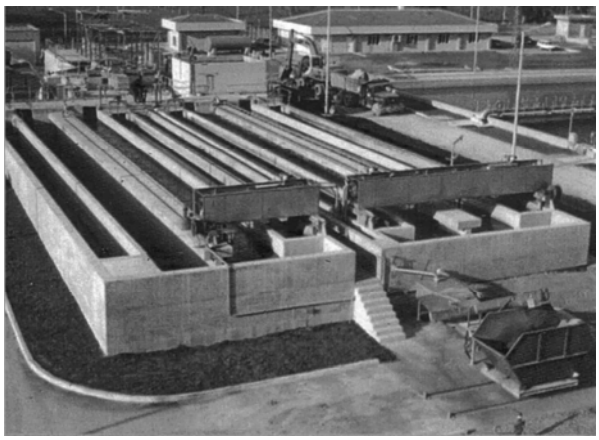
- Municipal Wastewater
- Industrial Wastewater

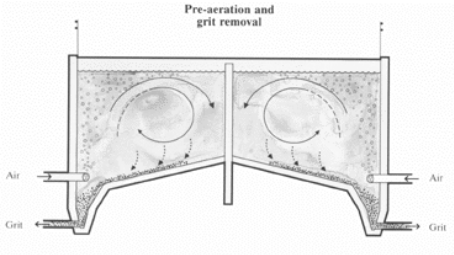
Why Grit Is Removed ?

- Prevent wear on pumps
- Accumulation in aeration tanks
- Accumulation in clarifiers
- Accumulation in digesters
- Clogging of sludge piping

How Grit Is Removed

- Horizontal-velocity settling chambers
- Diffused air chamber
- Square settling chambers





Horizontal-Velocity Grit Chambers

- They are controlled by either
  - A Parshall flume or
  - A proportional weir
- Parshall flume is used more widely due to less head loss than the weir
- The flume and weir are also used to measure flow rates
- In the chamber, a constant horizontal velocity is maintained by proper cross-sectional geometry of the chamber

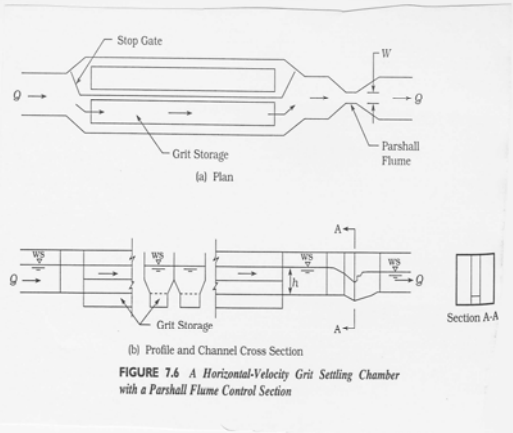
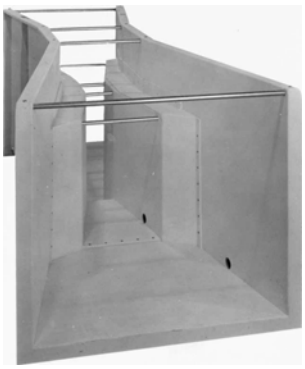


FIGURE 7.6 *A Horizontal-Velocity Grit Settling Chamber with a Parshall Flume Control Section*



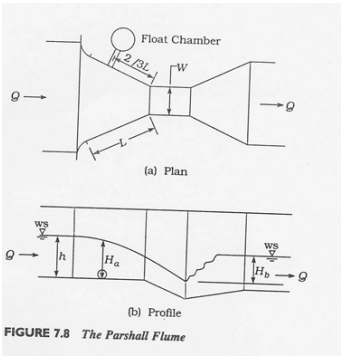


FIGURE 7.8 *The Parshall Flume*

Discharge equation for Parshall flume

$$Q = CWH_a^{1.5}$$

- Q = discharge, ft^3/sec (m^3/s)
- C = 4.1 for USCS units and 2.26 for SI units
- W = throat width, ft (m)
- H_a = upstream depth, ft (m)

➢ The equation is used with free-flow water (no backflow effects) and Q is a function of H_a

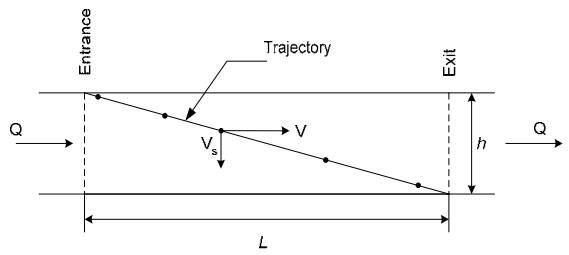
Horizontal-Velocity Grit Chambers

- Horizontal velocity must be adequate to keep organic matter in suspension
- Horizontal velocity should not be sufficient to scour settled grit along the bottom of the channel
- Values between 0.23 and 0.38 m/s are common

Design of Horizontal-Velocity Grit Chambers

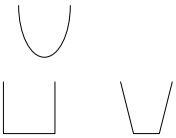
- Once the cross sectional area is determined, the theoretical length must be determined.
- For a particle entering the chamber, the time required for it to settle to the bottom at the exit of the chamber is:
  - $t = h/V_s$ where:
  - h = water depth, V_s = settling velocity, t = settling time
- The horizontal distance that the particle travels is the theoretical length:
  - L = Vt where:
  - L = theoretical length
  - V = horizontal velocity
- The actual length is 1.35 times the theoretical length

Trajectory of a particle in a Horizontal-Velocity Grit Chambers



Channel Geometry

- If Parshall flume is used:
  - Parabolic is ideal
  - Practically, a combination of rectangular and trapezoidal areas

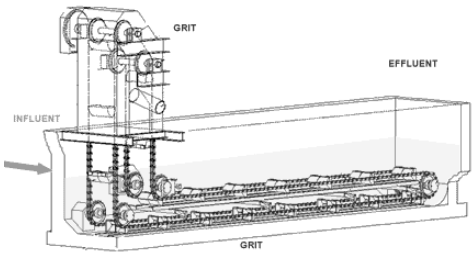


- If proportional weir is used:
  - Rectangular is ideal

Grit Chamber, Essen, Germany.

Aerated Grit Chambers

- Shape of Chambers
  - Rectangular (for medium to large treatment plants)
  - Square (for small to medium treatment plants)
  - Circular (for small to medium treatment plants)
- Air flow rate should be adjusted so that grit is removed 100%
  - If velocity is low, organic particles may be removed along with the grit
- Grit is removed by chain-driven buckets
- Detention time ranges between 2 to 5 minutes and is based on the peak flowrate
- Design criteria is shown in the next Table



Criteria for Aerated Spiral Roll Grit Chamber

Item	Value	
	Range	Typical
Dimensions Depth, ft (m) Length, ft (m) Width, ft (m)	 7 - 16 (2.1 - 4.9) 25 - 65 (7.6 - 19.8) 8 - 23 (2.4 - 7.0)	
Width : depth ratio	1 : 1 – 5 : 1	1.5 : 1
Length : width ratio	3 : 1 – 5 : 1	4 : 1
Detention time at peak flow, min	2 – 5	3
Air supply, ft^3/min-ft of length (m^3/min-m of length)	2 – 5 (0.18 – 0.46)	
Grit quantities ft^3/MG ($m^3/10^3$ m^3)	0.5 – 27 (0.004-0.200)	2.0 (0.01)