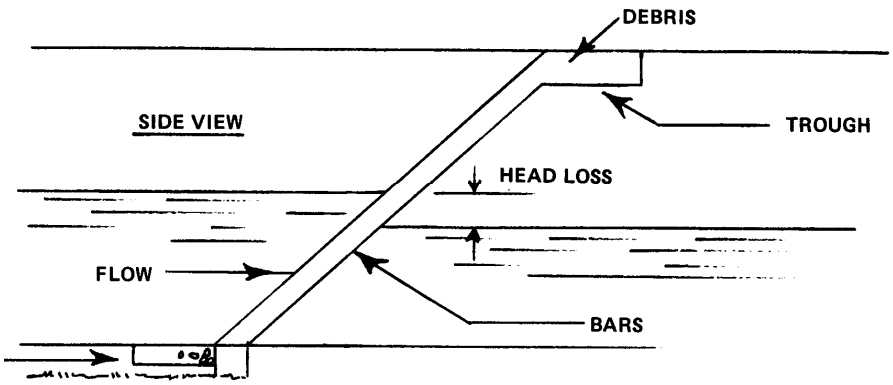
PLANT PRETREATMENT

The removal of solids from the incoming wastewater flow is accomplished in steps. The first steps involve physical separation of the solids by screening and by gravity. The larger solids can be removed using screens and the heavy solids can be removed using settling processes. The dissolved organic material (and some of the lighter suspended solids) will remain in the sewage flow after primary clarification. The first step in the solids removal process is screening to remove the larger solids and "rags." After screening, a grit removal process is used to separate the heavier inorganic solids like sand and inert organics like coffee grounds from the flow. Rags can clog piping and pumps in downstream processes. Grit can also cause clogging problems and can damage pumps. Grit that isn't removed in the grit chamber will end up in the solids handling system where it will eventually collect in the digesters. This will reduce available digester capacity. These processes that remove inorganic solids are collectively referred to as pretreatment.

BAR SCREENS

A bar screen consists of a series parallel of steel bars that are placed vertically in the influent flow channel. The bars are usually spaced about 1/2-3/4 inches apart. In some cases, two sets of screens are placed in the channel the upstream screen may have bars spaced 2-3 inches apart and the downstream screen will have the normal spacing. The front screen is sometimes referred to as a "trash screen." It is designed to catch large chunks of debris to avoid overloading the smaller screen. As the screen gets clogged with rags the water level upstream will rise. If the screen isn't cleaned regularly the upstream water level can back up and flood the structure.



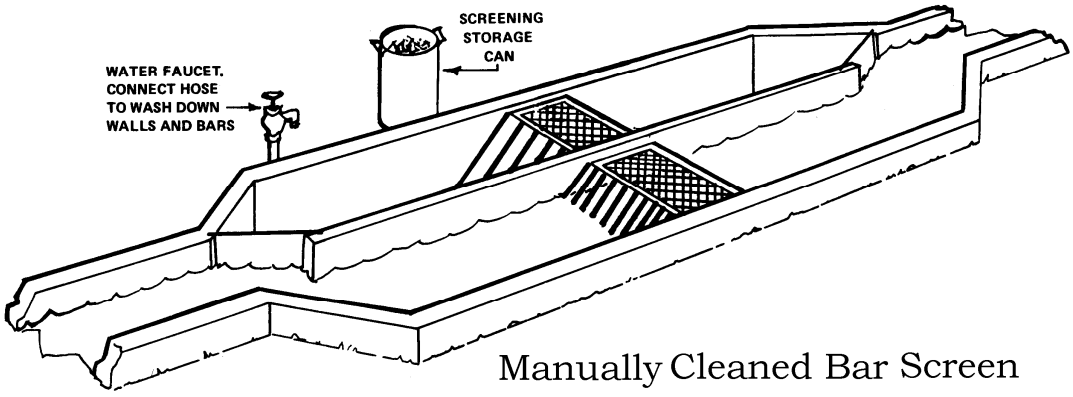
Manually Cleaned Bar Screen

An operator must rake the collected debris from a manually cleaned bar screen. Manually cleaned bar screens are usually set at a 45-degree angle. This makes it easier to rake the debris from the screen.

Automatically cleaned bar screens are designed with a set of rakes that are chain-driven. These units will operate periodically to remove the rags and deposit them in some type of container. The bar screen angle is usually between 60 and 90 degrees on an automatically cleaned screen system. The rags that are removed by the screen must be hauled to a landfill for disposal. However, some screen systems actually rake the screens, grind or shred the rags, and then return them to the waste flow.

Incoming septic sewage can cause corrosion problems with steel screens. Hydrogen sulfide formed by anaerobic decomposition will attack the metal bars. Bar screens should be inspected several times a year for corrosion and bent bars. Repair and replacement of the bars is the only maintenance issue for manually cleaned screens. Automatically cleaned screens need to have weekly inspections to check the conditions of the rake teeth and the chain drive.

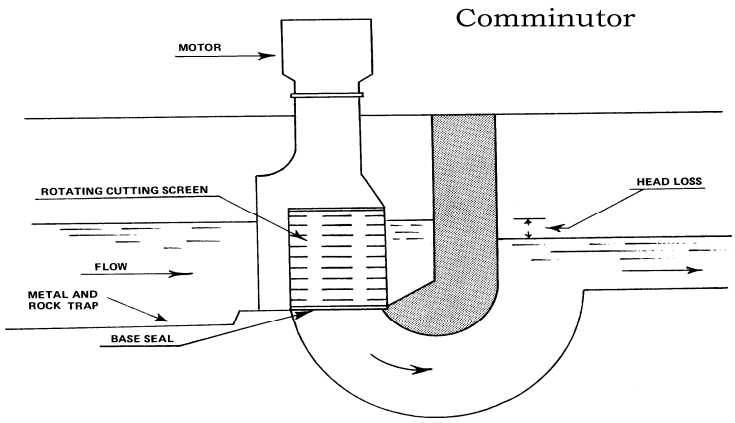
Bar Screens are used to separate large debris such as rags and plastics.

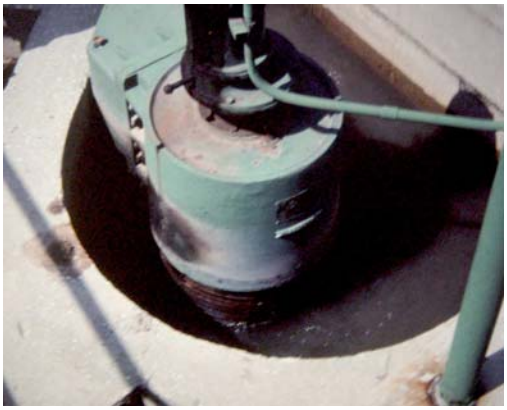


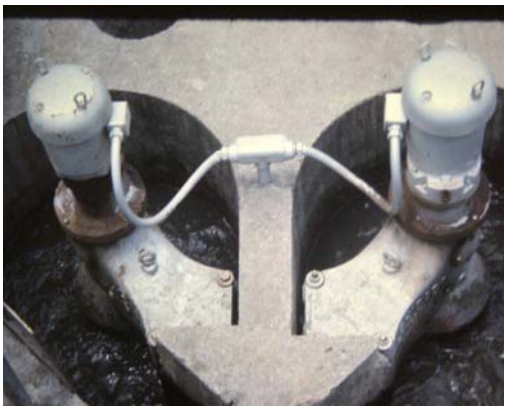
Manually Cleaned Bar Screen

COMMINUTORS AND GRINDER PUMPS

A comminutor is a device that is designed to shred rags and debris into small pieces. It takes the place of a bar screen. Debris collects on the cage of the comminutor and a set of revolving teeth cut the rags up into pieces small enough that they won't clog pumps and pipes. Grinder pumps or macerators, such as the "Muffin Monster," also grind up debris as it flows through the pump. Comminutors or grinders will normally be placed in parallel with a manually cleaned bar screen. The bar screen is usually set up in parallel so it can be used when the comminutor is down for service.





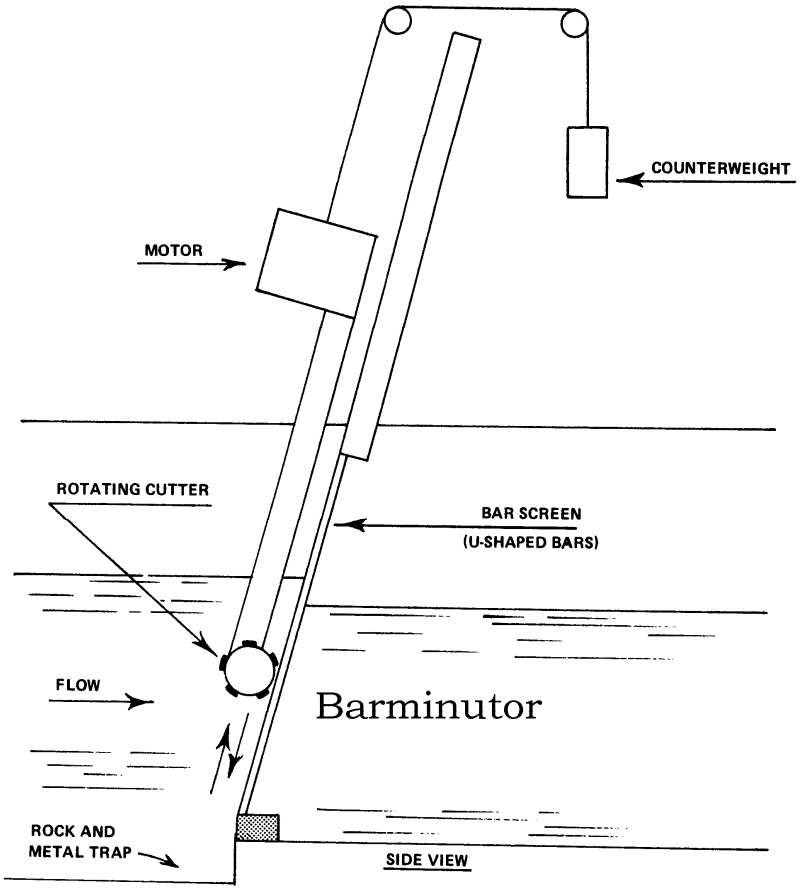


Comminutors grind rags into small chunks instead of removing them.

The advantage to chopping up the rags is that it eliminates the need to collect and landfill the debris. However, the chopped up rags can still become a problem in solids handling processes because they are now removed with the primary sludge. Like automatically cleaned bar screens, comminutors, and barminutors have higher maintenance cost than manually cleaned screens. The most important item is the inspection of the cutting assembly. When the cutting teeth get worn the risk of jamming the cutting assembly increases. If worn cutting blades are not replaced and the unit suddenly becomes jammed severe damage to the gearbox and shaft can occur.

BARMINUTORS

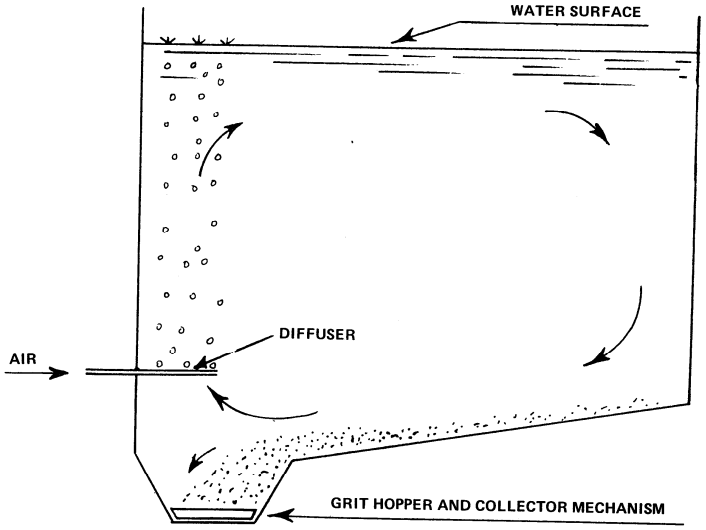
A barminutor is a combination of a bar screen and a comminutor. The bar screen traps the rags and a rotating cutter runs down the screen to cut up the rags every 15-30 minutes. Gearboxes and bearings must be kept full of grease to prevent water intrusion. If too much debris builds up on the bars the cutter can jam.



GRIT CHAMBERS

The downward slope of a sewer line must be sufficient to maintain a minimum velocity of 2 feet per second in the pipe. The 2 fps velocity will prevent grit from settling in the sewer lines. This velocity is maintained until the flow enters the treatment plant. The grit is removed from the flow as it passes through a grit chamber. The velocity in the grit chamber is reduced to about 1 foot per second. When the velocity drops to 1 fps, the heavier grit particles will settle out and the lighter organic material will stay in suspension and continue on into the primary clarifiers. There are several different designs for grit chambers.

The first grit chambers were rectangular channels 30 to 60 feet long. A proportional weir at the effluent end of the channel would create a water depth that reduced the velocity to 1 fps. There were usually two of these grit chambers installed in parallel. Drop gates were used to isolate a channel so that the collected grit could be shoveled or removed with a clamshell bucket. The grit that comes out of the grit chamber may still have some organic material in it. It can be washed to remove the organics in an effort to reduce objectionable odors. Grit material should be landfilled.



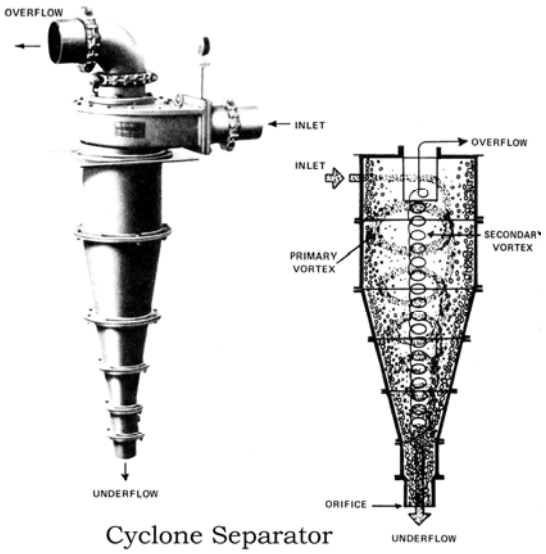
Aerated Grit Chamber

Aerated grit chambers are much larger and deeper than non-aerated units. The 1 fps velocity is maintained by using aerators to create a rolling flow in the tank. The detention times are increased to 10-45 minutes. This also helps create aerobic conditions in septic sewage. Aerobic conditions help improve the settleability of the sludge and increase both BOD and suspended solids removal in the primary clarifiers. Aeration is achieved using diffusers located on the bottom of one side of the grit chamber. As the rolling motion is established, the grit collects at the bottom of the tank.

Mechanical augers at the bottom of the grit chamber move the grit to one end of the tank where grit slurry pumps can pump it out of the tank to a grit separator.

Aerated Grit Chambers improve grit separation and also aerate the incoming sewage to reduce odors.

The most common type of grit separator is called a cyclone separator. Water and grit are pumped into a cylinder that tapers to a cone on one end. The flow whirls around the inside of the cylinder like a cyclone. Centrifugal force slings the heavy grit to the outside, where it slowly works it way to the bottom of the cone. The water overflows from the cylinder end and is returned to the waste stream.



Cyclone Separator

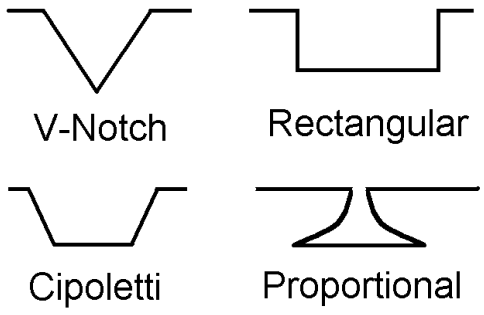
Grit is separated and deposited in a grit classifier (left side) and the water is returned as a sidestream (right side).

FLOW MEASUREMENT

The rate of flow through the treatment plant is a very important piece of operational data. It is used to calculate process hydraulic and organic loading, detention time, surface loading rates, and weir overflow rates in the various treatment processes. The flow measurement readings for the plant are taken at the head works, either before or after the pretreatment processes. Open channel flow measurement is the most common means of measuring wastewater flows.

OPEN CHANNEL WEIRS

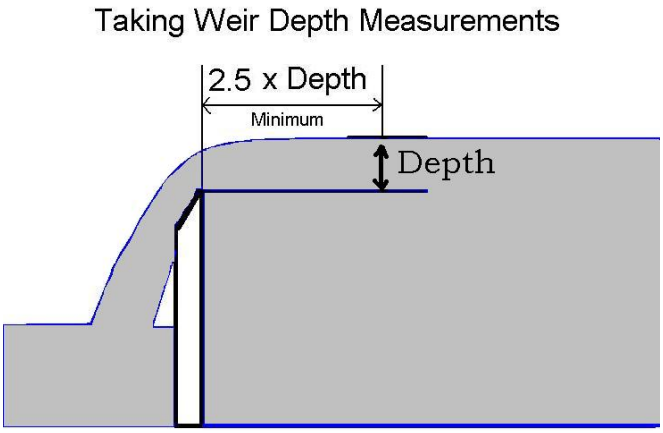
A weir is a sharp-edged plate that is inserted into an open channel for the purpose of gauging the flow in the channel. Weir plates can be V-notched, rectangular, or trapezoidal (Cipoletti weir). The V-notch weir is used for small flows. The rectangular weir is used for high flows. The Cipoletti weir is basically a combination of the V-notch and rectangular opening. Proportional weirs are used to maintain the proper velocity in an open channel grit chamber.



MEASURING FLOWS IN OPEN CHANNELS

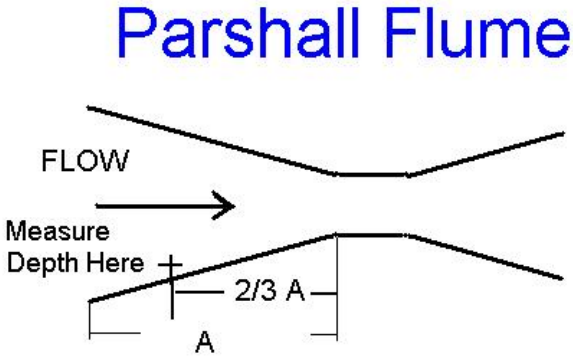
The flow over a particular weir is determined by measuring the depth of water going over the plate. This depth can be converted to a flow by calculation or use of a weir flow chart. In order to gauge the depth accurately, the measurement must be taken at a point upstream of the weir plate.

The depth measurement must be taken at a distances at least 2.5 times the depth upstream from the weir. The main disadvantages of weir for influent flow measurement are that debris can get hung up in the notch and grit can settle upstream of the weir plate.



PARSCHALL FLUMES

Small systems may be able to use weir plates to measure influent flows. Larger plants will use a Parschall flume as the measuring device. Parschall flumes measure a wide range of flows with acceptable accuracy and they have no sharp edges that can catch debris.



The velocity through the flume increases. This prevents grit from collecting. A Parschall flume is shaped like an hourglass. As the flow increases, the upstream depth increases. Like the weir, the depth of the water in the flume must be measured upstream of the neck in the center. This point is two-thirds of the distance from the neck to the front of the flume.

FLOW EQUALIZATION BASINS

Treatment processes would work better if the flow through the plant were constant. But that's not the case. The flow through the system fluctuates on a daily basis. Treatment plant operators learn to adjust operating parameters when these fluctuations occur. Most of the time these changes need to happen in preparation for the flow change. If changes are made as a reaction after the fact, it will be much more difficult to control the biological processes.

Flow equalization basins are designed to smooth out the hydraulic and organic peaks that occur during the day. They can also prevent hydraulic washouts that can occur during storms. The resulting inflow and infiltration can raise the flows to levels that can threaten many activated sludge processes. These basins can be designed as a flow-through part of the process or they can be side-streamed during peak flows and later metered back into the plant in the evenings when the flow drops down. The diverted flows must be returned daily. The contents of the equalization basin must also be aerated and mixed during storage. This will prevent the sewage from going septic and also prevent sludge from accumulating in the basin.

Splitter boxes are used when parallel processes exist. If there are three primary clarifiers, the flow should be split evenly to achieve the best overall removal rate. The gates in a splitter box must be adjusted to achieve this. Check the depth of the water in each primary clarifier effluent channel as adjustments are made.

BASIC STUDY QUESTIONS

1. What do bar screens remove?

2. How does a grit chamber work?

3. What is a weir used for?

BASIC SAMPLE TEST QUESTIONS

1. What is the best angle for a manually cleaned bar screen?

   A. 10 degrees
   B. 30 degrees
   C. 45 degrees
   D. 90 degrees

2. Where do screenings go?

   A. To the digester
   B. To the landfill
   C. To the recycling station
   D. Back into the flow

3. A comminutor is used:

   A. To measure flow
   B. To digest inorganic solids
   C. To grind up rags and debris
   D. To call the plant manager

4. The velocity in a grit chamber should be about:

   A. 1 foot per second
   B. 2 feet per second
   C. 4 feet per second
   D. 10 feet per second

ADVANCED STUDY QUESTIONS

1. As a bar screen gets clogged, what happens to the upstream water level?

2. Where should you take a depth reading on a parschall flume?

3. What should you do if you notice an increase in organic materials in the grit from an aerated grit chamber?

4. What is the purpose of a flow equalization basin?

ADVANCED SAMPLE TEST QUESTIONS

1. The detention time in an aerated grit chamber should be:

   A. 15-30 seconds
   B. 1-3 minutes
   C. 5-10 minutes
   D. 15-40 minutes

2. A weir measurement must be taken:

   A. At the notch
   B. 2.5 times the depth upstream
   C. 2.5 times the depth downstream
   D. With a sludge blanket locator