How Wastewater Treatment Works - The Basics

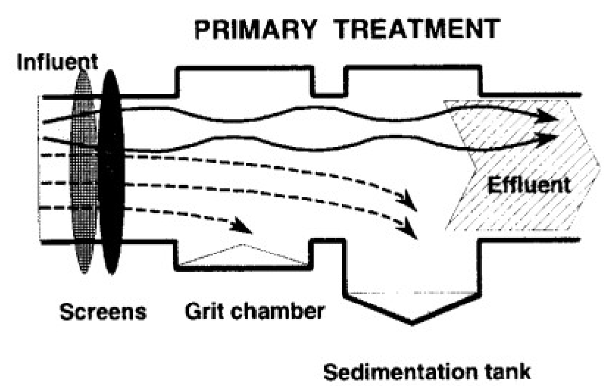
One of the most common forms of pollution control in the United States is *wastewater treatment*. The country has a vast system of collection sewers, pumping stations, and treatment plants. Sewers collect the wastewater from homes, businesses, and many industries, and deliver it to plants for treatment. Most treatment plants were built to clean wastewater for discharge into streams or other receiving waters, or for reuse.

Years ago, when sewage was dumped into waterways, a natural process of purification began. First, the sheer volume of clean water in the stream diluted wastes. Bacteria and other small organisms in the water consumed the sewage and other organic matter, turning it into new bacterial cells; carbon dioxide and other products. Today's higher populations and greater volume of domestic and industrial wastewater require that communities give nature a helping hand.

The basic function of wastewater treatment is to speed up the natural processes by which water is purified. There are two basic stages in the treatment of wastes, *primary* and *secondary*, which are outlined here. In the primary stage, solids are allowed to settle and removed from wastewater. The secondary stage uses biological processes to further purify wastewater. Sometimes, these stages are combined into one operation.

Primary Treatment

As sewage enters a plant for treatment, it flows through a *screen*, which removes large floating objects such as rags and sticks that might clog pipes or damage equipment. After sewage has been screened, it passes into a *grit chamber*, where cinders, sand, and small stones settle to the bottom. A grit chamber is particularly important in communities with combined sewer systems where sand or gravel may wash into sewers along with storm water.



After screening is completed and grit has been removed, sewage still contains organic and inorganic matter along with other suspended solids. These solids are minute particles that can be removed from sewage in a *sedimentation tank*. When the speed of the flow through one of these tanks is reduced, the suspended solids will gradually sink to the bottom, where they form a mass of solids called *raw primary biosolids formerly sludge*). Biosolids are usually removed from tanks by pumping, after which it may be further treated for use as a fertilizer, or disposed of in a land fill or incinerated.

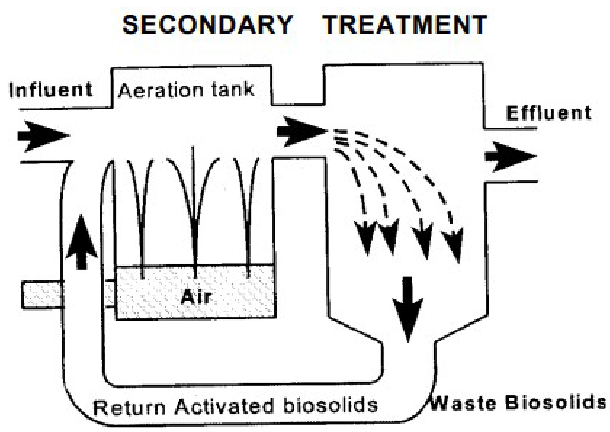
Over the years, primary treatment alone has been unable to meet many communities' demands for higher water quality. To meet them, cities and industries normally treat to a *secondary treatment level*, and in some cases, also use advanced treatment to remove nutrients and other contaminants.

Secondary Treatment

The *secondary stage* of treatment removes about 85 percent of the organic matter in sewage by making use of the bacteria in it. The principal secondary treatment techniques used in secondary treatment are the *trickling filter* and the *activated sludge process*.

After effluent leaves the sedimentation tank in the primary stage it flows or is pumped to a facility using one or the other of these processes. A trickling filter is simply a bed of stones from three to six feet deep through which sewage passes. More recently, interlocking pieces of corrugated plastic or other synthetic media have also been used in trickling beds. Bacteria gather and multiply on these stones until they can consume most of the organic matter. The cleaner water trickles out through pipes for further treatment. From a trickling filter, the partially treated sewage flows to another sedimentation tank to remove excess bacteria.

The trend today is towards the use of the activated sludge process instead of trickling filters. The activated sludge process speeds up the work of the bacteria by bringing air and sludge heavily laden with bacteria into close contact with sewage. After the sewage leaves the settling tank in the primary stage, it is pumped into an *aeration tank*, where it is mixed with air and sludge loaded with bacteria and allowed to remain for several hours. During this time, the bacteria break down the organic matter into harmless by-products.



Activated Biosolids Process

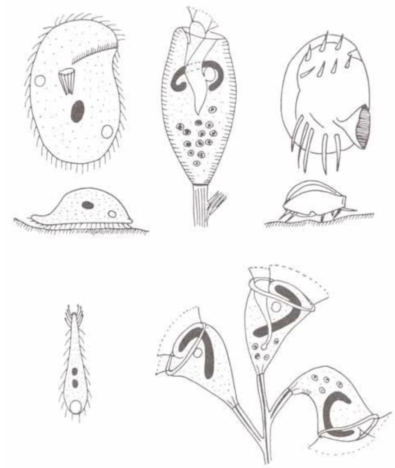
The sludge, now activated with additional billions of bacteria and other tiny organisms, can be used again by returning it to the aeration tank for mixing with air and new sewage. From the aeration tank, the partially treated sewage flows to another sedimentation tank for removal of excess bacteria.

To complete secondary treatment, effluent from the sedimentation tank is usually *disinfected* with chlorine before being discharged into receiving waters. Chlorine is fed into the water to kill pathogenic bacteria, and to reduce odor. Done properly, chlorination will kill more than 99 percent of the harmful bacteria in an effluent.

Some municipalities now manufacture chlorine solution on site to avoid transporting and storing large amounts of chlorine, sometimes in a gaseous form. Many states now require the removal of excess chlorine before discharge to surface waters by a process called *dechlorination*. Alternatives to chlorine disinfection, such as ultraviolet light or ozone, are also being used in situations where chlorine in treated sewage effluents may be harmful to fish and other aquatic life.

Other Treatment Options

New pollution problems have placed additional burdens on wastewater treatment systems. Today's pollutants, such as heavy metals, chemical compounds, and toxic substances, are more difficult to remove from water. Rising demands on the water supply only aggravate the problem. The increasing need to reuse water calls for better wastewater treatment. These challenges are being met through better methods of removing pollutants at treatment plants, or through prevention of pollution at the source. Pretreatment of industrial waste, for example, removes many troublesome pollutants at the beginning, not the end, of the pipeline.



Five common ciliated protozoa found in wastewater treatment (left to right, top to bottom): (a) Chilodonella uncinata, (b) Opercula microdiscum, (c) Aspidisca costata, (d) Trachlophyllum pusillum and (e) Carchesium polypinum; (a) and (c) are crawling ciliates, (b) and (e) stalked ciliates and (d) a free-swimming ciliate

To return more usable water to receiving lakes and streams, new methods for removing pollutants are being developed. *Advanced waste treatment techniques* in use or under development range from biological treatment capable of removing nitrogen and phosphorus to physical-chemical separation techniques such *filtration*, *carbon adsorption*, *distillation*, and *reverse osmosis*. These wastewater treatment processes, alone or in combination, can achieve almost any degree of pollution control desired. Waste effluents purified by such treatment, can be used for industrial, agricultural, or recreational purposes, or even drinking water supplies.