

City of Waukesha

Wastewater Treatment Process

INFRASTRUCTURE

Infrastructure refers to that part of the system that carries the wastewater to the Plant for treatment. The City of Waukesha has over 260 miles of sanitary sewer piping. The pipes that carry the flow through the City range in size from 8 to 72 inches in diameter. Wherever the pipes must make a bend or junction with other pipe, there is a manhole to provide access for cleaning and observation. The pipes are cleaned on an annual basis and more often if necessary.

The water flows by gravity. The piping has a mild slope downward and the water flows in the direction of the slope. Eventually, the pipe carries the water to collection chambers (lift stations) at predetermined depths. In these stations pumps lift the water upward and allow it to flow downward to the next lift station until it reaches the Plant. Waukesha presently has 42 lift stations with more planned as the City expands. In areas where the water must be piped uphill, it is pumped under pressure through pipes called force mains.

PRELIMINARY TREATMENT

Preliminary treatment is required for the removal of as much solid matter as possible prior to further treatment. This is accomplished by first passing the wastewater through a bar screen which removes large objects such as roots and rocks. Rags, plastic and some paper are then removed using a fine screen. The fine screen is a moving screen belt equipped with tines to catch the material. Finally, the smaller particles like sand, pebbles and seeds are taken from the stream using a grit chamber. The grit chamber consists of a series of paddles which move counter to the flow, slowing the flow enough to allow the grit to drop to the bottom and be removed.

Each of these processes has a mechanism by which the material is removed from the unit. The bar screen is cleaned manually. The fine screen drops the matter from the belt into a rag hopper. The grit chamber has an auger system that moves the grit to the grit hopper.

PRIMARY TREATMENT

After grit removal, the water cascades in waterfall fashion into two wet wells. This increases the dissolved oxygen content and enhances odor control and subsequent treatment processes. The water is pumped 50 feet upward from the wet wells using 165-horsepower pumps. Each pump can move 9,400 gallons per minute with a combined flow of over 46 million gallons per day during high rainfall periods. The Plant presently treats 10 to 12 million gallons per day and is designed to handle 18.5 million gallons per day average and a peak flow of 23 million gallons per day.

Next the waste is processed in primary clarifiers, which are tanks with sloped bottoms. In these clarifiers the solids settle to the bottom and are swept to a central drain. Floating materials such as oil and grease are skimmed off.

From here the water flows by gravity to the roughing filters. These units actually don't "filter". They contain fist-sized limestone (media) which over time becomes coated with microorganisms that degrade the wastes. The wastewater is distributed onto the media by rotating arms that evenly spray the water over the stone. The water "trickles" down through the media, which is why these units are also known as trickling filters. On the way through the media the wastes are degraded by the microorganisms that cover the stone. In winter when the temperature falls sharply, the distributor arms can freeze up and so the trickling filters are covered with domes to reduce heat loss. At present, the roughing filters are not in use. The Plant is operating successfully without them.

Water flows from the roughing filters into the primary effluent pump station. This building contains five 177-horsepower pumps with a capacity of over 60 million gallons per day. From this station, the water is pumped to a splitter box where it is mixed with return activated sludge (RAS). The RAS is wastewater that contains the essential microorganisms used in biodegradation of the organic matter. The splitter box distributes the RAS-enriched water to six aeration basins.

SECONDARY TREATMENT

At the heart of the treatment process are the aeration basins, large mixing tanks where the microorganisms feed on the organic waste materials. Oxygen is necessary for this process. To provide the oxygen for both the waste degradation and mixing of the wastewater, the tanks are lined with rows of piping along the bottom that carry air to diffusers. These diffusers break the flowing air into bubbles that dissolve in the water and provide agitation as they float to the top. The microorganisms thrive as they feed on the wastes in the presence of oxygen. The microbes grow and multiply, and the waste is converted into larger particles that come together as a brown fluffy mass called floc. This floc settles

very rapidly. In addition to the carbon-based wastes, nitrogen compounds and ammonia nitrogen are also removed.

The inside of an aeration tank is 50 ft. by 250 ft. long and has an average water depth of 18 ft. Each of the six tanks contains 1,683,000 gallons for a total of 10,098,000 gallons. Air is provided to the tanks by 700-horsepower blowers. The dissolved oxygen concentration in the water determines the amount of air needed. The dissolved oxygen can be controlled either manually or automatically.

The treated wastewater is next sent to final clarifiers to separate the activated sludge floc from the water. The sludge is divided in two parts. One part, the Return Activated Sludge (RAS) is sent back to the splitter box to be mixed with the incoming wastes to provide the bacteria for treatment. The second portion is sent to a thickener as Waste Activated Sludge (WAS). Air is pumped under pressure into the WAS. As the WAS is opened to the atmosphere the air is released as fine bubbles causing the solids to float where they can be skimmed off.

TERTIARY TREATMENT

Tertiary treatment refers to the polishing of the water prior to discharge to the river. The processes of tertiary treatment include phosphorus removal, sand filtration, and ultraviolet disinfection.

Phosphorus is a primary nutrient for growth and must be removed prior to discharge to prevent overgrowth of algae and vegetation. Excess plant growth depletes the oxygen in the river as it decomposes. In order to remove phosphorus, ferric (iron) chloride is added to the wastestream in the coagulation basins. The iron ties up the phosphorus as a solid which is separated from the water in the basins along with other solids which may have gotten past the final clarifiers. These solids are sent to the head of the Plant for reprocessing.

There are still small particles remaining that must be removed. The water next enters the sand filters. These filters consist of three layers: gravel, anthracite coal and sand. As the water passes through the filter media, all but the finest solids and bacteria are removed.

The finest solids are inconsequential at the levels leaving the sand filters. However any bacteria which remain must be made harmless. The water passes through banks of submerged ultraviolet lamps to disable remaining bacteria. The water is now ready to flow into the river.

SOLIDS

There are three sources of solids from the Plant: rags, grit and biosolids (also referred to as sludge). Rags and grit are sent to a licensed landfill site for disposal. Thickening of the Waste Activated Sludge is accomplished using dissolved air flotation. In this process air is forced into the sludge. As the air disperses it causes the floc to float to the top where it is skimmed off. The water from below is sent to the head of the Plant for processing.

The thickened WAS is sent to anaerobic (oxygen-deficient) digesters, where the sludge is further degraded. An entirely different set of microorganisms is present in the digesters. Methane gas is one of the products of anaerobic degradation. The gas is burned to heat the sludge and keep the culture active. As fresh WAS is pumped into the digesters, the degraded sludge is sent to a storage tank.

The sludge in the storage tank has been both aerobically (with oxygen) and anaerobically (without oxygen) degraded. It is 1-3% solids. With the solids content this low it is most cost effective to dewater the sludge for transport.

Knowing the characteristics of sludge is the key to understanding the dewatering process. Sludge is composed of water and small particles that remain suspended. The particles will remain suspended almost indefinitely. In order to break the suspension, a chemical "polymer" is added. The polymer is a long chain compound that attracts a number of the small sludge particles to it. The result is a chained particle that no longer remains in suspension but separates from the water. The water is separated from the solids by pressing it between two porous belts that allow the water through but not the solids. The solids now contain 18-22% water. Most of the water that remains in the solids at this point is contained within the dead bacterial cells that make up the sludge. The solids are stored until either spring or fall when approved agricultural fields are open to land application. The sludge is scattered in a thin layer on the fields and tilled under within six hours of application.

CONCLUSION

Although complex, the Waukesha Wastewater Treatment Facilities are very efficient and successful at protecting the quality of our water resources, for the enjoyment of all. We invite you to contact us to arrange a tour and see firsthand the processes that turn wastewater into clean, reusable water.