YCUA's Wastewater Treatment Process

The Wastewater Department is responsible for the operation and preventive maintenance activities at the Wastewater Treatment Plant. Plant operations include preliminary treatment, septage receiving, primary treatment, secondary treatment, tertiary treatment, biosolids processing, disinfection, and odor control. Plant operators are staffed 24 hours per day, 365 days per year. The treatment plant's annual average design flow is 51.2 million gallons per day. Following is a brief explanation of each of the treatment plant's processes:

Aerial View of YCUA Wastewater Treatment Plant

PRELIMINARY TREATMENT

Wastewater enters the plant at the Grit and Screen Building passing through one of three available automatic bar screens where materials such as sticks and rags are mechanically removed from the wastewater. Wastewater then enters one, two, or three grit chambers (66,000 gallons each) where the flow rate is decreased allowing for materials like sand, gravel, and other heavy particulates to settle out. Materials lighter than water such as oils and greases, typically referred to as scum, can be removed at the surface of the chambers. Material which settles out in the chambers, termed grit, is removed, washed, and dewatered for off-site disposal. The treatment plant disposes of approximately 50-60 cubic yards of grit each month.

Following preliminary treatment, wastewater is routed into one of ten available treatment passes. A treatment pass is comprised of a primary settling tank, aeration tank, and secondary settling tank. When flow exceeds the established set point for these treatment passes, wastewater is routed into equalization tanks (total capacity of 4 million gallons) where aeration can minimize odors by keeping the wastewater fresh and solids in suspension. If the volume of these tanks are exceeded, wastewater overflows into a 9 million gallon retention basin. If the retention basin's capacity is also exceeded, wastewater will overflow into a chlorine contact chamber where provisions for chemical disinfection can be implemented. If capacity is available, all wastewater stored in the equalization tanks, retention basin, and chlorine contact chamber can be returned to the treatment process. If the capacity of the chlorine contact chamber is exceeded (1.84 million gallons, total capacity of equalization, retention, and the contact chamber is 14.84 million gallons), the partially treated wastewater will be mixed with fully treated wastewater leaving the plant. It is estimated that during a 25 year storm event when the influent peak flow may reach 102 million gallons per day, the plant will be able to treat the design flow and have sufficient retention capacity to store flow in excess of 63 million gallons per day.

View of Retention Basin during original plant construction.

SEPTAGE RECEIVING

The treatment plant is designated and approved by the Michigan Department of Environmental Quality as a septage receiving facility. YCUA only accepts domestic septage waste. Annually, the treatment plant accepts approximately 4-5 million gallons of septage. Septage waste is pumped into the treatment plant with the wastewater entering the Grit and Screen Building.

PRIMARY TREATMENT

After preliminary treatment, wastewater is split into one of ten primary settling tanks (855,000 gallons each). Flow velocity is significantly reduced at this point which provides the wastewater approximately 2-3 hours of detention time. This allows sufficient time for the settleable solids to drop to the bottom of the tanks and the lighter materials to float to the surfaces. The settleable solids are referred to as primary sludge. Once the sludge settles, it is collected and removed for dewatering. Scum that floats to the surface is skimmed off of each tank, dewatered, and hauled off-site for disposal. The treatment plant disposes of approximately 10 cubic yards of scum each year.

SECONDARY TREATMENT

Effluent from the primary settling tanks contains soluble and colloidal impurities which were not significantly reduced in prior treatment processes. For example, these would include phosphorus and ammonia. Secondary treatment employs an activated sludge process which removes these impurities. The term “activated” comes from the fact impurities are mixed with oxygen, bacteria, fungi, protozoa, and continuously recirculated (termed return sludge) through the process to develop a brown floc which consists of billions of microorganisms. Secondary treatment begins when primary effluent flows into the aeration basin influent and is mixed with return activated sludge. The mixture flows through one of ten aeration basins (2.16 million gallons each). Microorganisms use (metabolize) most of the suspended and dissolved material found in wastewater as their food source which converts it into new cells, carbon dioxide, and additional water. Biological phosphorus removal is achieved by exposing the microorganisms to alternating anaerobic (without oxygen) and aerobic conditions. Alternating between these conditions favor microorganisms which naturally store food and release phosphorus for energy in the anaerobic zone, but use the food and store phosphorus in the aerobic zone. When the microorganisms are removed from the process (specified volume determined daily), phosphorus is also removed. Provisions are also available for the plant to supplement biological removal with chemical precipitation of phosphorus by utilizing aluminum sulfate. Ammonia is removed by utilizing a nitrification process. Nitrification is a two-step biological conversion of ammonia to nitrite then to nitrate under aerobic conditions.

View of aeration basin

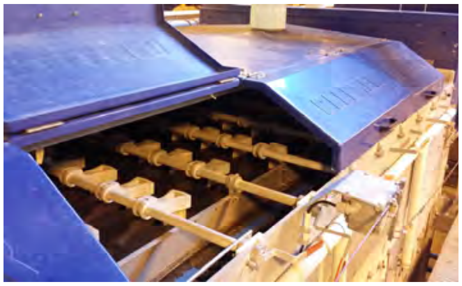
Aeration basin liquid (termed mixed liquor) flows into one of ten secondary settling tanks (1.02 million gallons each) where the biological solids will readily settle out. The settled material, termed return sludge, is removed from the bottom of the tank and directed back to the influent of the aeration basin. A portion of the return sludge is removed from the system daily, a process known as wasting.

TERTIARY TREATMENT

Effluent from the secondary settling tanks is pumped through one of eighteen rapid sand filters. Filtration removes any remaining particulate matter not removed in prior treatment processes. Effluent from the secondary settling tanks typically contains around 10 parts of suspended solids per million liters of water. Effluent after tertiary treatment typically contains less than 1 part of suspended solids per million liters of water.

BIOSOLIDS (SLUDGE) PROCESSING

Primary sludge is stored in Primary Solids Storage Tanks (4 tanks with a capacity of 430,000 gallons each). Waste activated sludge is stored in up to five tanks (1.37 million gallons of total capacity) and can be dewatered with gravity belt thickeners. During processing, primary sludge and waste activated, or thickened waste activated sludge, are blended together at varying ratios and dewatered to approximately 25% total solids. Dewatering occurs in up to nine belt filter presses which remove water by chemical coagulation, gravity separation, and pressure filtration. Dewatered sludge is pumped to a Fluidized Bed Sewage Sludge Incinerator which was put on-line in 2006. The primary purpose of incineration is to reduce the quantity of material which requires disposal. Incineration results in the combustion of the biosolids producing an inorganic residue, typically referred to as ash. During combustion, the organic part of the biosolids is primarily converted into carbon dioxide and water vapor. Approximately 13,000 tons of dry biosolids are processed through the incinerator annually. In 2007, YCUA received an Honor Award by the American Council of Engineering Companies for a World Class Biosolids Incineration System.



View of upper portion of a belt filter press during gravity separation.

The main component of incinerator is the fluidized bed reactor. During static conditions, the fluid bed reactor consists of an inert sand bed supported on an air distributor dome. Air is forced up through the dome and sand causing the individual particles in the bed to “fluidize.” This fluidized state promotes an intensive mixing of the individual sand particles with the fluidizing air, which is used as combustion air for the incineration process. Particles in the fluidized layer behave like a boiling liquid. The high heat transfer rate and intensive mixing in the fluid bed result in extremely uniform combustion. The fluid bed reactor has three main sections of which two are physically separated. At the bottom of the reactor is the windbox, which is used to distribute air evenly to the sand but also contains a burner for preheating when necessary. In the middle bed section, natural gas and biosolids are injected into the fluidized sand media; this is where a majority of the combustion takes place. In the upper section of the reactor is the free board, which allows additional time for combustion of natural gas and biosolids. Hot gases containing ash exit from the top of the reactor and pass through two shell and tube heat exchangers. After the heat exchangers, the gases pass through four stages of air pollution control. The state-of-the-art air pollution control devices on the incinerator

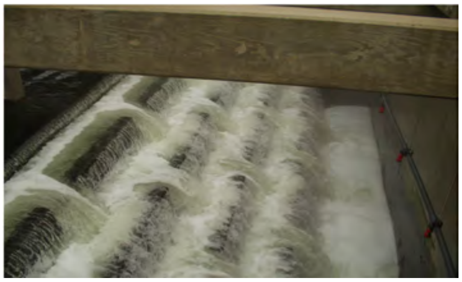
View at top of incinerator where exhaust gases first exit the reactor.

make it one of the cleanest air emission units of its kind in the United States. Air pollution control for exhaust gases are processed through a quenched venturi scrubber, impingement tray scrubber, wet electrostatic precipitator, and a granular activated carbon adsorber. Once the gases leave the secondary heat exchanger, they pass through a venturi scrubber which removes particulate matter from the gases by means of a water injection and an increase in the gas velocity at throat of the venturi. Gases from the venturi scrubber then pass through an impingement tray scrubber which removes condensable gas byproducts and lowers the temperature. After the tray scrubber, gases are passed through a wet electrostatic precipitator which removes very fine particulate matter. This is accomplished by introducing an electrical charge on the gas borne particles which causes them to be attracted to collector plates located inside the unit. After the precipitator, gases pass through the granular activated carbon system. This system is made up of a conditioner which removes water droplets and an absorber which removes trace pollutants such as mercury in the gas stream. After the adsorber, gasses pass through the exhaust stack and are properly dispersed into the atmosphere. Air emissions form the incinerator are regulated by an air permit issued by the Michigan Department of Environmental Quality.

Ash from the incinerator is pumped as slurry to one of two ash lagoons (11,000 cubic yards each). Dewatered ash is disposed of at a sanitary landfill every 3-5 years. Effluent from the ash lagoons is recirculated into the plant headworks and retreated.

WASTEWATER DISINFECTION BY ULTRAVIOLET RADIATION

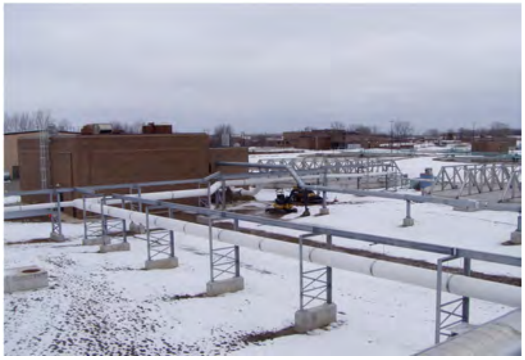
Effluent from tertiary filtration is routed through up to three channels of ultraviolet radiation (UV). Each channel contains 360 bulbs. The wavelength of the ultraviolet light is 254 nanometers. UV bulbs emit energy (light) that penetrates cell walls and destroy genetic materials. UV energy causes permanent inactivation of bacteria, viruses, and other microorganisms by disrupting their reproductive material therefore reproduction can no longer occur. In the event of a power outage, the plant can utilize a stationary diesel powered generator. Treated effluent flows by gravity to an effluent pump station where it is discharged to the Lower Rouge River. If the pump station is not available, the plant has approval to discharge treated plant effluent to Willow Creek which flows into Belleville Lake. The plant discharges approximately 650 million gallons of treated effluent on a monthly basis. All discharges from the plant are regulated by a permit issued by the Michigan Department of Environmental Quality.



View of cascade aeration at plant outfall

ODOR CONTROL

YCUA completed Phase I of our odor control plan in 2001 at a cost of 2.25 million dollars. Phase I consisted of odor control for the plant headworks (where the raw sewage first enters the plant). The purpose of the Odor Control Facility is to remove the malodorous elements of the foul air generated at the plant and discharge stable (scrubbed) air to the atmosphere. Odors generated from wastewater consist of a wide range compounds with diverse chemical natures. The most prominent odors are sulfur-bearing compounds such as hydrogen sulfide and mercaptans and nitrogen – bearing compounds such as ammonia and amines. Foul air is treated by neutralization with caustic solutions, or by oxidation with solutions like sodium hypochlorite. Compounds created from these treatments are less volatile than their original form.



View of Phase II Odor Control Ductwork

YCUA recently completed Phase II of our odor control plan in 2013. Phase II consisted of odor control for the biosolids (sludge) processing areas of the plant. Foul air from biosolids processing sources are conveyed into the first oxygenated zone of each aeration basin. Microorganisms in the aeration basins decompose the odorous compounds in the foul air through a form of biofiltration.

PLANT TOURS

The Wastewater Department offers guided tours of the Wastewater Treatment Plant. Tours of the plant can be arranged by completing a Tour Request Form. Tour participants must be at least 10 years old or in 5th grade. YCUA requires chaperones at a 1:8 ratio for school grades 5-8 and 1:15 ratio for school grades 9-12. YCUA can accommodate most large groups with advance notification. Please contact Sree Mullapudi by phone at 734-484-4600 Ext. 121 or by email at smullapudi@ycua.org for questions regarding tour guidelines and availability.

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