WASTEWATER TREATMENT AT WORK

INSIDE HPUD'S SYSTEM

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HALLSDALE-POWELL UTILITY DISTRICT

The complete guide to HPUD's wastewater treatment system.

COMMITTED TO EXCELLENCE

ABOUT OUR COMPANY

A BRIEF STORY ABOUT THE COMPANY

Hallsdale-Powell Utility District was established in 1954 to service a small portion of North Knox County with safe, reliable drinking water. In 1963, to support the growing areas in Powell and Halls Crossroad, HPUD began construction of the Beaver Creek Wastewater Treatment Facility. At the time, many homes relied on septic tanks or discharged water into nearby streams. Building a wastewater treatment plant helped to prevent pollution, protect local waterways, and allowed for future development of homes, businesses, and industries. This facility was an early investment in public health, environmental stewardship, and smart infrastructure planning.

YOUR WATER, OUR MISSION
UNDERSTANDING THE WASTEWATER PROCESS

CLEAN WATER STARTS WITH DIRTY WORK!

OVERVIEW

Hallsdale Powell Utility District's Beaver Creek Wastewater Facility has two distinct treatment trains to process wastewater. One train utilizes a conventional treatment approach using an oxidation ditch, clarifiers and tertiary filters. This part of the facility has been upgraded several times since its original construction in 1963. The second uses membrane filtration technology constructed in 2009. Both treatment trains use activated sludge processes.

Before we get started, let's go over some key words used in the treatment process that will help with understanding the basic steps and terminology used in wastewater treatment to help appreciate the science and engineering involved in turning dirty water into a clean safe resource.

KEY WORDS

INFLUENT

The untreated wastewater that flows into the treatment facility from homes and businesses.

EFFLUENT

The treated water that flows out of the wastewater plant after it has gone through various cleaning processes.

SUSPENDED SOLIDS

Tiny solid particles that remain floating in water. If not removed, these can cause pollution and harm aquatic life.

SLUDGE

The solid material removed from wastewater during treatment.

BIOLOGICAL TREATMENT

The use of bacteria and other microorganisms to break down organic matter in wastewater.

MICROORGANISMS

Tiny living organisms referred to as “bugs” that are mainly bacteria which break down organic matter and pollutants in sewage.

ACTIVATED SLUDGE

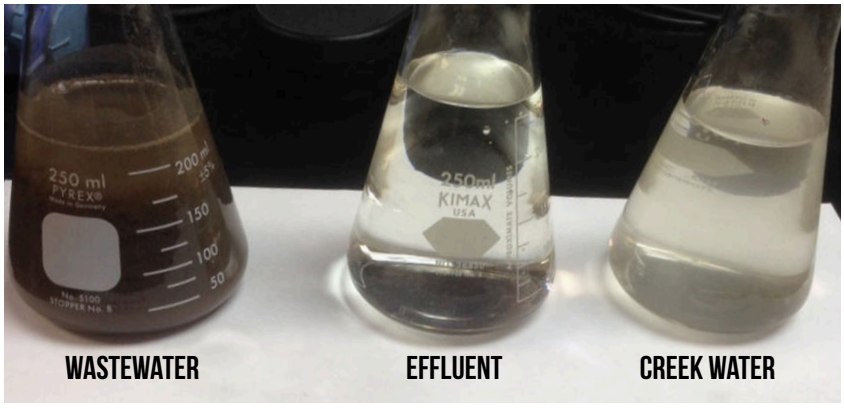
A process where microorganisms break down organic matter in the presence of oxygen.

AERATION

The process of adding air to wastewater, typically to provide oxygen for microorganisms in biological treatment.

PERMEATE

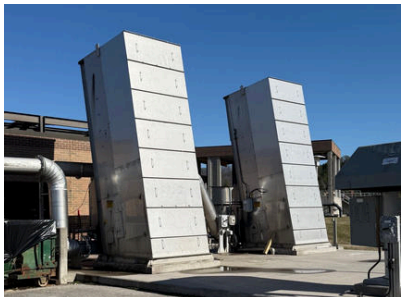
The clean, filtered water that has passed through a membrane during the wastewater treatment process free of suspended solids, bacteria, and other contaminants, making it suitable for discharge.

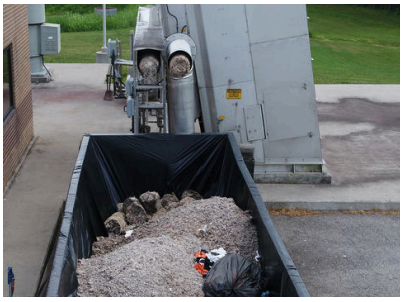


OUR PROCESSES

INFLUENT COARSE SCREENS

The Influent Coarse Screens are located at the entry point of the wastewater plant. All large debris-such as sticks, rags, food, scraps, and more-are screened out, collected, and sent to the landfill. Debris is screened out of the sewage with automated mechanical bar screens before it continues to the Grit Separation Tanks by way of large pumps in the wet well of the Influent Pump Station.





GRIT SEPARATION TANKS

The Grit Separation Tank removes heavier inorganics like sand, gravel, and other dense particles. These materials are abrasive and can damage the pumps and other equipment used downstream in the treatment process. The water travels through the grit chamber at a velocity and pattern which allows the small debris to settle out of the water and exit through a drain to be collected in a dumpster for disposal as shown below. The lighter organic solids in suspension in the water move on to the flow splitter where it is divided between the two treatment trains.

CONVENTIONAL TREATMENT SCHEME

CONVENTIONAL TREATMENT

The conventional side of the treatment plant involves the use of an oxidation ditch, clarifiers, and disk filter to treat wastewater. This system combines biological treatment with physical separation to reduce organic matter, suspended solids, and other pollutants.

OXIDATION DITCH

The oxidation ditch removes biodegradable organic matter through the action of microorganisms - commonly referred to as “bugs”. This process is known as the activated sludge process. Wastewater is aerated in the ditch to increase oxygen levels and create an ideal environment for the employment of naturally occurring microorganisms (bugs) to remove phosphorus and organics in the effluent. The wastewater is circulated for a prolonged period to allow the bugs to sufficiently break down the organic matter before it moves to the next process.

CLARIFIERS

Clarifiers (settling tanks) are a key component in the treatment process that helps to separate solids from water using gravity. The effluent should be free of solids at this point in the process.

Clarifiers are large round tanks with a rotating scrapper at the bottom of the tank and a skimmer arm at the top of the tank. The larger insoluble materials (sludge) settle to the bottom where the scrapper collects it into the sludge well for removal. Lighter material like grease and scum float to the top of the tank where the skimmer directs it into a trough located on the outside of the tank for removal. The cleaner water (effluent) flows out of the tank to the next stage of the process.

**The sludge that is removed from the clarifiers is sent to the digester for disposal.*

SLUDGE SETTLES TO THE BOTTOM WHERE THE SCRAPPER COLLECTS IT INTO THE SLUDGE WELL FOR REMOVAL

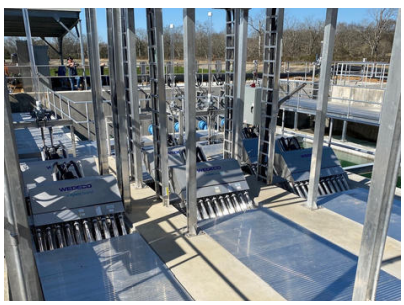
SCUM & GREASE FLOAT TO THE TOP WHERE IT IS COLLECTED AND REMOVED

DISK FILTERS

The disk filters are the final stage of filtration in the conventional process scheme. The disks are like a giant water strainer used at the end of the treatment process to catch tiny bits that other steps missed. It helps make the water super clean before it's released by using big spinning disks covered in cloth that trap small particles of dirty water as it flows across the disk. As the cloth gets dirty, the system automatically cleans itself by spraying water backward to wash off the gunk so that the filters can keep working as it cleans itself. The disk filters are great for saving space and energy. The remaining solids are directed back to the beginning of the plant and the treated water is allowed through.

ULTRAVIOLET DISINFECTION

Once the wastewater has been through the treatment process, it is sent to the Ultraviolet (UV) Disinfection Chamber. UV disinfection in a process that uses ultraviolet light to kill or inactivate the remaining harmful microorganisms before it is released into Beaver Creek. The water passed over UV lamps that emit short-wavelength UV-C light. The UV light damages the DNA of bacteria and virus preventing them from reproducing or causing damage. The advantages of UV disinfection are it's chemical free, fast and effective destroying a wide range of pathogens quickly, and it is environmentally friendly as it doesn't create harmful byproducts.



MEMBRANE FILTRATION TECHNOLOGY

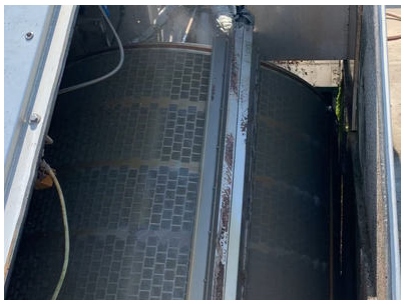
Pictured below is the Membrane Bioreactor adjacent to the conventional treatment side of the plant. This side of the plant uses membrane filtration technology to treat wastewater and produces a final product rivaling most drinking water plants. The MBR is designed to treat an average of 6.0 million gallons per day (MGD) and can manage a peak flow of 9.3 MGD for a period of 72 hours.

This process starts after the wastewater has gone through the Influent Coarse Screens and the Grit Separation Tank.

MEMBRANE FILTRATION TREATMENT

FINE SCREENS

At the head of the MBR are the fine screens. The screens remove one more layer of debris from the wastewater to protect equipment and make the treatment process more efficient. From here, it enters the bioreactors to begin treatment as shown below.



The two tanks shown below are the heart of biological process which removes nutrients such as nitrogen and phosphorus as well as carbonaceous biological oxygen demand and solids. The process utilizes microorganisms (bugs) to do the work of removing the contaminants mentioned previously. In this process, the environment is carefully managed to maintain different types of bugs in each zone of the reactors to reduce solids and nutrients.

MEMBRANE TANKS

Once the wastewater has traveled through the reactor, it will enter the membrane tanks where the water and solids are separated by the membrane filters. In this process, the membranes use vacuum pressure the draw water from the outside of the membranes to the inside and exclude the solids. In the picture below, you see an operator showing the membranes and how solids are filtered out while producing ultra clean water. The membranes are controlled by an software program that manages the flow rates, work load, and prevents the system from damaging the membranes.

The left behind sludge is sent to the digester for disposal.

The advantages of the MBR is it is a compact design and it delivers superior effluent quality that exceeds required standards.

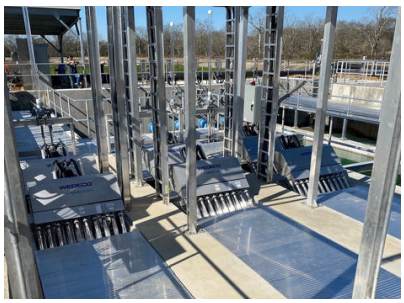
The membranes require constant aeration to prevent solids from collecting and gelling on the membrane fibers. The large blowers shown on the left provide air to the membranes to prevent damage. In addition, the blowers deliver air to the reactors to provide oxygen to the bugs. The 6 blowers are divided into two groups and are controlled by computers. Three blowers are dedicated to the membrane process and the other three are dedicated to the aeration zone of the reactors. The amount of air delivered to the reactor is regulated by a software program and oxygen probes in the reactor tank.

On the right, several pumps and other support equipment serve to route liquids to different locations in the process as needed. The large pumps on the left-hand side of the picture are used to return solids rejected by the membranes back to the reactor for further treatment. The smaller pumps directly behind the return pumps provide the vacuum to the membranes mentioned above to separate the water and solids and deliver the water to the next step in the treatment process.

The room (left) is the control center for the entire MBR. Here operators can make changes to the process and monitor productivity. The computer screen will show operators how each part of the plant is performing, show alarms if problems exist, and provide trends of the previous day's activities. This allows the operator to make changes or decisions to keep the plant running smoothly and produce a high-quality product.

ULTRAVIOLET DISINFECTION

Once the wastewater has been through the MBR, it is sent to the Ultraviolet (UV) Disinfection Chamber. The water passed over UV lamps that emit short-wavelength UV-C light. The UV light damages the DNA of bacteria and virus preventing them from reproducing or causing damage before the treated water is released into Beaver Creek.



SOLIDS TREATMENT

Solids treatment manages all of the solids (sludge) removed during the treatment process from the clarifiers, disk filters, and membrane tanks. The goal is to reduce the volume, remove pathogens, and make the material easier to handle for disposal.

The main steps in the solids treatment process are thickening, digesting, and dewatering. Thickening reduces the sludge volume by removing excess water prior to digesting. The digestion process stabilizes the sludge and reduces the pathogens, organic matter, and odor making it easier to handle. Dewatering removes more water from the sludge by using a centrifuge. The centrifuge spins around similar to a washing machine removing the water leaving a substances referred to as “cake”. The cake is fed onto a conveyor that feeds it into a tractor trailer bed to be disposed of at the landfill.

CENTRIFUGE

SOLIDS TREATMENT

WASTEWATER COLLECTION SYSTEM

BY THE NUMBERS

Service Area
146 Square Miles

Manholes
10,106

Treatment Plants
2 Wastewater Treatment Plants
2 Decentralized Treatment Plants

Force & Gravity Mains
493 Miles

Storage Tank
(1) 5 Million Gallon Storage Capacity

Sewer Connections
25,085

Lift Stations
22

AWARDS

Clean Water Professionals of Kentucky & Tennessee

2024 CLEAN WATER TECHNOLOGY AWARD

The Beaver Creek Wastewater Treatment Plant Ultra Violet Disinfection System

2024 OUTSTANDING OVERFLOW ABATEMENT PROJECT AWARD

The Beaver Creek Sewer Interceptor Improvement Project

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