VILLAGE CREEK WATER RECLAMATION FACILITY

ENVIRONMENTAL MANAGEMENT SYSTEM (EMS)
BIOSOLIDS BENEFICIAL RESUSE/RECYCLING

NATIONAL BIOSOLIDS PARTERNSHIP (NBP)
EMS CERTIFIED
7TH AGENCY IN THE UNITED STATES
1ST AGENCY IN TEXAS

BIOSOLIDS EMS MANUAL
INTRODUCTION

VILLAGE CREEK WATER RECLAMATION FACILITY
CITY OF FORT WORTH WATER DEPARTMENT

BACKGROUND

The Village Creek Water Reclamation Facility (VCWRF) serves more than 1.2 million people and numerous industries in 23 communities. The City of Fort Worth owned and operated plant is permitted and capable of processing 166 million gallons of wastewater each day.

The service area consists of most of Tarrant County and portions of Denton, Johnson, and Parker counties. As part of the Dallas/ Fort Worth Metroplex, it is one of the largest and fastest growing areas in the United States that does not have a major waterway for disposal of treated wastewater.

The VCWRF and surrounding areas discharge treated effluent into the sensitive Trinity River. During dry months, the river may be composed of up to 95% treated wastewater, making the VCWRF performance critical to the Trinity's vitality and usefulness as a drinking water source for those downstream.

The biosolids produced from the treatment process (90 dry tons per day) are processed and stabilized resulting in Class AB biosolids. The City's goal is to beneficially reuse/recycle all of the biosolids produced at the City's dewatering facility (located one mile north of the VCWRF) through land application on area farms and ranches in Tarrant and eight surrounding counties.

WASTEWATER TREATMENT PROCESS

The VCWRF uses the same purification methods found in nature: settling, filtration, and biological activity. Plant design and operation allow the purification and stabilization processes to take place in a much smaller space, within a shorter time frame, and at a low cost. The "Village Creek Water Reclamation Facility Description" table presented later in this section lists some of the methods utilized at the plant.

The City of Fort Worth wastewater collection system consists of approximately 3,300 miles of sanitary sewer. The majority of the system utilizes gravity flow; however, the City maintains over 50 pump stations to service the lower lying areas within the basin. The wastewater enters the VCWRF through two 96-inch sewer collector mains and one 90-inch sewer collector main. As the wastewater enters the plant, chlorine is added to provide seasonal odor control. The flow volume is measured using Parshall flumes.

Headworks-Bar Screens & Fine Screens

The wastewater flow entering the plant goes through the Headworks Facility. The flow passes through "roughing" bar screens—a row of closely and evenly spaced bars across the influent channel (1 ¾ inch openings). The "roughing" bar screens remove large objects that could block pipes or damage equipment. The bars are cleaned periodically with an automated mechanical rake and the material removed from the bars is taken to a sanitary landfill.

A new Headworks Facility was constructed in 2005 to remove more materials at the beginning of the treatment process. The new facility is equipped with 6mm fine screens. The 6mm fine screens capture and remove suspended solids, rags, plastics, etc. from the wastewater flow and the screens are mechanically cleaned. The material captured by the fine screens is compacted and taken to a sanitary landfill. Fine screens have also been installed in one bay of the existing Bar Screen Building #3. The remaining bays in Bar Screen Building #3 have 1-inch bars and are maintained for emergency use.

Headworks Facility

High Rate Clarifier

High Rate Clarifier Building

The High Rate Clarifier (HRC) is designed and permitted to treat high flow situations. Whenever instantaneous flows to the Headworks Facility equal or exceed 255 million gallons per day (MGD), wastewater flow processed in the HRC can be discharged directly to the facility's disinfection units. This allows for adequate detention times in the primary and secondary treatment stages. The HRC can treat 100 MGD. Also, during heavy rain, wastewater can be pumped from the HRC to the Peak Flow Basin (PFB) and brought back later for treatment. The sludge generated by the HRC will flow to the gravity belt thickeners to remove excess water. The liquid is sent to secondary treatment and the concentrated sludge is fed into the sludge blend tank.

Peak Flow Storage Basin

The construction of a Peak Flow Storage Basin (PFSB), located at the Sludge Only Landfill, was completed in 2017. The PFSB gives plant staff operational flexibility by storing the elevated influent flows that typically occur during wet weather events. This helps lower the flows going through VCWRF during these peak flow conditions, thereby reducing the stress on each of the wastewater treatment units. Eventually the stored wastewater at the PFSB is brought back to VCWRF for treatment.

Peak Flow Storage Basin

Primary Treatment

After passing through bar screens, the wastewater flow goes to the primary clarifiers. In these large circular tanks, the wastewater flow is slowed to about one foot per minute so heavier solid materials can settle to the bottom. Grease and oil (scum) that floats to the surface is screened before being sent to the anaerobic digesters.

Aeration Basins and Final Clarifiers

The solids that settle out (sludge) are pushed to the center of the clarifier (sedimentation tank) and pumped to the sludge degritting facility for removal of sand and gravel. The wastewater that overflows the weirs is then pumped to secondary treatment.

Secondary Treatment

The VCWRF uses conventional activated sludge as the heart of its treatment process. The biological treatment mimics the processes used by nature for purifying lakes and streams.

Primary Clarifiers

This process biologically converts pollutants that will not settle into substances that will settle. The wastewater is mixed with bacteria-rich activated sludge in large aeration basins. Compressed air is fed through fine bubble diffusers to provide the bacteria and other microorganisms with enough oxygen to support the biological process in the wastewater. The bacteria consume organic matter in the wastewater; it is essential that this process is controlled to minimize the biological "burning up" of organic material.

Dissolved and suspended impurities in the wastewater are incorporated into the activated sludge floc through adsorption (when solids stick to the surface of the bacteria) and absorption (when dissolved gases and solids are taken into the bacteria where they can be assimilated) by the microorganisms.

The mixture of treated wastewater and activated sludge from the aeration basins is then transferred to final clarifiers where gravity separates the microorganisms from the wastewater. The clarified wastewater again overflows the clarifier weirs and moves on to the effluent filtration phase of treatment.

The majority of the settled activated sludge is returned to the aeration basins to continue the treatment process. A small portion of the sludge is pumped to the Waste Sludge Concentration. Scum floating on the surface of the final clarifiers is screened and pumped to the co-digestion building.

Effluent Filtration

The remaining solids suspended in the wastewater are removed by the passing of the wastewater through multimedia filters composed of gravel, sand and anthracite coal. Filters are cleaned periodically by "backwashing," or sending clean water backward through the filter which flushes out impurities. During backwashing, the filter bed expands and media particles bump against each other, allowing impurities to be washed away. Newer filters use only sand and a traveling bridge that continuously backwashes the filter, one small cell at a time.

Traveling and Deep Sand Bed Filters

Backwash water is moved to an equalization basin and fed at a constant rate to the backwash clarifier, where the solids settle out. Solids are transferred to the Waste Sludge Concentration and clarified backwash water is filtered again.

Chlorination / Dechlorination

After effluent filtration, the wastewater enters the chlorine contact basins, where it is mixed with chlorine and held for 20 minutes for disinfection. The chlorine kills pathogens and bacteria that remain in the effluent. However, since chlorine and its by-products are toxic to aquatic life, sulfur dioxide is added after chlorination to remove the chlorine residuals. Sulfur dioxide dissolves in water to form sulfite, which reacts immediately with chlorine to form harmless chloride ions. After chlorination and dechlorination, the wastewater looks much like drinking water and is discharged to the Trinity River.

Chlorine Contact Basin

Reclaimed Water

Type I Reclaimed Water: Effluent from the deep media filters is sent to the ultraviolet (UV) disinfection system where a bank of UV modules treats up to 6 MGD. Then a pump station, consisting of three 200 hp vertical turbine pumps, pumps the water into the distribution system. Each of these pumps has a design capacity of 4 MGD and typically operate in the range of 55-90 pounds per square inch (psi). A chlorine booster station helps provide residual chlorine in the distribution system, which in turn supplies reuse water to three wholesale customers (City of Arlington, City of Euless, DFW Airport) as well as retail customers within the City of Fort Worth.

Type II Reclaimed Water is currently provided to the Waterchase Golf Course. In the future, this service will be converted to Type I Reclaimed Water.

Village Creek Reclaimed Water Pump Station

Primary Sludge Degritting/Concentration

The sludge that settles to the bottom of the primary clarifiers is pumped to the Grit Removal Facility. The heavy inorganic particles, such as fine sand and small gravel (grit), are removed using cyclone degritters. The grit is classified (washed) and moved by conveyors to roll-off containers. After being allowed to air-dry at the drying beds, it is hauled to a landfill for final disposal.

Grit Removal Facility

After degritting, sludge flows to gravity thickeners to remove excess water. The liquid in the thickener overflows a weir and is returned to primary treatment and the thickened primary sludge (approximately 2.0-2.5% solids) is fed to the Sludge Blend Tank. At this stage, the primary sludge is mixed and blended with secondary sludge and is fed to the anaerobic digesters.

Waste Sludge Concentration

The VCWRF uses dissolved air flotation thickeners (DAFT) and gravity belt thickeners to concentrate the waste activated sludge from the final clarifiers. In the DAFTs, compressed air is pumped into a mixture of water and waste sludge. Small bubbles of air form on the sludge particles making them less dense than water which causes the sludge to float on the surface of the DAFT. The concentrated floating sludge is removed by a skimmer and pumped to the Sludge Blend Tank. The remaining liquid (subnate) is pumped to the secondary treatment area for further processing. At the gravity belt thickeners, waste sludge is mixed with polymer and spread onto a porous moving belt. Water separates from the sludge and passes through the belt, leaving the sludge more concentrated.

Anaerobic Digesters and DAFTs

Scum Removal

All floating materials from the various treatment processes are moved to the scum holding tanks. It is then screened and pumped to the co-digestion building. The scum is mixed with high strength waste before being pumped to the blend tank.

Anaerobic Digestion / Stabilization

The blended sludge is fed to the anaerobic digesters from the blend tank. The digesters provide an environment where anaerobic bacteria (bacteria that cannot live with oxygen present) are able to thrive and can break down the organics in sludge into stable compounds.

Anaerobic digestion reduces solids, odors, and pathogens; and it conditions sludge which makes dewatering more rapid. Methane gas, produced as a by-product of this process, is used to power mixers inside the digesters. The biogas and/or other gas, such as natural gas, is used onsite to power gas turbine engines which generate electricity. The exhaust heat from these turbines is run through a heat recovery system to create steam which powers two (30,000 SCFM) steam blowers. The air produced by the steam blowers supplies oxygen to the aeration basins and reduces the electricity requirements of electric blowers that would otherwise be utilized.

In September 2012, VCWRF completed construction of a high strength waste unloading station and began accepting high strength waste (i.e., food processing waste). The codigestion of wastewater solids and high strength wastes has increased the onsite production of biogas and reduced the amount of fuel needed for the gas turbine engines.

Co-Digestion Building

A treatment system located at VCWRF, adds chlorine dioxide to digested sludge before it is pumped to the City's dewatering facility. Chlorine dioxide is a powerful oxidant for pathogen control that helps mitigate odors and permit longer periods of biosolid storage before land application.

Chlorine Dioxide Treatment System

A station installed at the City's dewatering facility uses ferric chloride to remove phosphorus from digested sludge which optimizes water removal in the belt filter presses and prevents struvite formation that clogs system pipelines. Use of ferric chloride also reduces costs by decreasing the amount of polymer needed for the treatment process.

Ferric Chloride Station

Covered Thickeners, Air Scrubbers, and Biofilters

Odor Control

The VCWRF is located near a growing residential area, and controlling odors generated by the plant is a high priority. Many of the treatment processes, such as bar screening and cyclone degritting, are enclosed in air-scrubbed buildings.

The primary sludge thickeners, waste sludge DAFTs and the weirs of the primary clarifiers are also covered and scrubbed. The VCWRF uses both wet scrubbers and carbon adsorption scrubbers. Other odor control measures include the addition of chlorine to incoming wastewater, use of biofilters, optimization of treatment processes and maintenance of good housekeeping around the plant.

VILLAGE CREEK WATER RECLAMATION FACILITY DESIGNS				
Plant Loadings			**Filtration**	
Rated capacity, MGD	166		Dual-media gravity filter	20
Average daily flow (2016-2017), MGD	112		Continuous backwash filter	12
Discharge Standards			**Disinfection**	
CBOD, mg/L	7		Chlorination contact time, minutes	20
Total Suspended Solids, mg/L	15		Dechlorination, MGD	166
Discharge Performance (2016-2017)			**Sludge Processing**	
Average CBOD, mg/L	2.0		65-foot diameter primary sludge thickener	4
Average Total Suspended Solids, mg/L	2.1		Gravity Belt Thickeners	2
Pretreatment			DAFT unit	4
Bar Screen Unit			80-foot diameter anaerobic digester	2
Primary Treatment			90-foot diameter anaerobic digester	12
80-foot diameter clarifier	12		Sludge drying beds (standby)	225 acres
160-foot diameter clarifier	6		**Contract Dewatering**	
Secondary Treatment			Belt-Filter Press (2 meter)	6
Conventional activated sludge with fine bubble diffused air			Liquid Sludge Holding Tank	2
			Lime Storage Silo & Pug Mill	1
Aeration Basins			**Centrifugal Blowers**	
3.41 million gallons	6		60,000cfm electric blower	1
3.37 million gallons	6		25,000cfm electric blower	5
1.54 million gallons	4		30,000cfm steam blower	2
Final Clarifiers			**Electricity**	
150-foot diameter	9		Heat Recovery Steam Generator	1
130-foot diameter	4			
110-foot square	2			
95-foot diameter	6		5.2MW Steam Blowers	2

BIOSOLIDS BENEFICIAL REUSE

History

The Fort Worth Water Department has always been dynamic and progressive in the area of beneficial reuse of sludge (biosolids). VCWRF staff are committed to the goal of beneficial reuse of all biosolids produced via land application.

Air-dried biosolids have been beneficially recycled and reused since the opening of the first Fort Worth Water Reclamation Facility in 1923. Although the Riverside Wastewater Treatment Plant closed in 1980, operations continued until the early 1990s at the Village Creek Water Reclamation Facility (VCWRF). The air-dried biosolids from the drying beds were beneficially reused on area highway easements and medians as a soil amendment and fertilizer through agreements with the Texas Department of Transportation. Parks, golf courses and the plant nursery operated by the City also used biosolids fertilization to sustain and enhance grass and tree growth.

In response to population growth, plans for plant expansion, and implementation of new regulatory requirements during the late 1980s, the Fort Worth Water Department began exploring new options for digested sludge treatment. With an abundance of surrounding farm and ranch lands, North Texas area is an ideal location for beneficial reuse/recycling of biosolids by land application. The City selected mechanical dewatering by belt-filter presses as the most cost-effective process for future operations.

Biosolids Dewatering (Belt-Filter Press)

Belt-filter Press

Through a contractual agreement in 1991, VCWRF privatized 40% of the biosolids dewatering, transportation and beneficial land application. The initial program was successful and well-accepted by the public. As the program continued, the Contractor was authorized to process an increasing percentage of the total digested sludge from the VCWRF.

The Dewatering Facility is located one mile north of the VCWRF at the Sludge Only Landfill (SOL) site. The private contractor operates and maintains belt-filter presses used to mechanically dewater (press and squeeze moisture out of) the biosolids at the Dewatering Facility. Polymer is added to the biosolids as a conditioner and to aid the dewatering process. The processed and dewatered biosolids (16-18% solids) are conveyed to a pug mill where lime is added for pathogen control.

Lime Storage Silo & Pug Mill

Class AB Biosolids

On September 10th, 2014 the Texas Commission on Environmental Quality (TCEQ) amended the existing biosolids regulations as defined in 30 TAC Chapter 312. The revised regulations included a new designation for biosolids (Class AB) as well as requirements for odor control plans and the posting of signage at land applications sites. The new provisions became effective on October 2, 2014, at which time the Fort Worth land application activities assumed the new "Class AB" classification. Class AB biosolids result from the combination of excellent pretreatment, full anaerobic digestion (21-25 days at 97˚F), the chemical addition of ferric chloride and chlorine dioxide, and post-lime stabilization. The Class AB biosolids are beneficially reused/recycled as a fertilizer and soil conditioner.

Biosolids Application with Spreader

Beneficial Recycling by Land Application

The biosolids produced at Village Creek WRF amount to approximately 90 dry tons per day are beneficially reused/recycled as a fertilizer and soil amendment by land application in Tarrant and eight surrounding counties. A private contractor transports and land applies the Class AB biosolids at agronomic rates on cropland and pastureland.

Public / Private Partnership

Since 1991, Village Creek WRF has partnered with a private contractor, to provide beneficial reuse/recycling of biosolids produced. This positive and long-term public/private partnership facilitates joint problem solving, cohesive communication and dedication to safe recycling of biosolids.

Benefits of Biosolids Fertilization

Agricultural users of Fort Worth Biosolids have observed and documented:

- Increased hay and crop production
- Enhanced crop and forage quality
- Improved and enhanced soil conditions
- Increased soil organic matter aggregation, plant rooting, and soil tilth
- Increased cow/calf grazing pressure
- Higher total digestible nitrogen content
- Decreased soil erosion
- Increased nutrient availability throughout crop growing season

Sludge Drying Beds

Approximately one mile northeast of the VCWRF lies 240 acres of sludge drying beds. From 1970-1995, the drying beds were the final step (dewatering by natural air-drying) in biosolids processing. The biosolids were removed from the beds each summer and beneficially reused/recycled as a fertilizer and soil conditioner on area parks, golf courses, highway easements, and farmlands.

Village Creek Drying Beds

In April 1995, Village Creek ceased pumping sludge to the drying beds. The biosolids that remained in the drying beds and adjacent stockpiles were removed and beneficially reused as a fertilizer and soil amendment under a series of contracts from 1996-2001.

The final biosolids were removed from the drying beds in October 2001, thereby completing the removal contracts.

The drying bed site is currently maintained as an emergency back-up for sludge storage, as outlined in the City's Master Plan.

A unique feature of the drying beds is the abundance of birds and wildlife that have been drawn to the area over the years. The nutrient-filled water teems with life which attracts a variety of animals. The drying beds have been used for over 30 years as a feeding and nesting area for local birds and other wildlife. Due to the availability of water and the remoteness of the site, the area is also a resting stop for migratory birds on the Central Flyway of the United States.

ENERGY RECOVERY / RECYCLING

Village Creek Water Reclamation Facility is dedicated to using its resources efficiently, and that includes recycling energy as well as biosolids recycling. Biogas, which contains approximately 62% methane gas, is produced as a byproduct during anaerobic digestion. Although the City has historically used the biogas on site at the VCWRF, there are other options to efficiently and cost-effectively power the generators. The biogas generated at the VCWRF has increased in value and is now sold to external customers. The turbine engines are currently operated with less expensive natural gas.

Biogas Turbine

The City operates turbine engines to generate electricity for general plant use, and steam that provides compressed air via steam blowers to the aeration basins. The engines can be run on digester gas, natural gas, landfill gas, or diesel fuel.

In the future, the VCWRF may be able to utilize both gas turbines simultaneously to generate a significant portion of the plant's electricity requirements and export excess energy to an external grid.

Heat Recovery Steam Generator & Duct Burner

Heat Recovery Steam Generator & Duct Burner

In June 2012, the construction of a heat recovery steam generator (HRSG) was completed. The HRSG recovers heat from the exhaust of the gas turbines and a supplementary biogas-fueled duct burner to produce steam. The steam is then used to drive the steam blowers that provide compressed air for the energy-intensive aeration process in the treatment basins. The use of steam, rather than electricity, reduces the City's costs significantly.

VCWRF SUPPORT SECTIONS

Laboratory

The Water Department's Laboratory Services section analyzes wastewater and sludge samples collected throughout the day from all treatment phases. Staff chemists and microbiologists use automation to help analyze wastewater samples. Results are used for process control, monitoring treatment effectiveness and reports to regulatory agencies.

Analyses include metals and priority pollutants in the influent, effluent and sludge, microbial counts, oil and grease, organics and inorganics, dissolved oxygen and suspended solids in the aeration basis, and anaerobic digester activities for methane gas production.

Laboratory Sampling and Analysis

Pretreatment Services

The City of Fort Worth's wastewater treatment program begins with the Pretreatment Services. Pretreatment Services is responsible for monitoring and controlling wastewater pollution from commercial and industrial sources as authorized by a city industrial waste ordinance.

Pretreatment Sampling

Wastewater enters the VCWRF from the City of Fort Worth and 23 wholesale customer cities. Pretreatment Services monitors this wastewater for toxic substances that could create a hazard in the sewage system and/or inhibit or damage the plant's biological treatment processes.

Specifically, Pretreatment staff work with non-compliant industries and wholesale customer cities within the framework of an enforcement response plan to reduce toxic substances discharged to VCWRF. Semi-annually, all significant industrial users submit reports outlining their compliance status with the ordinance and permit conditions of the pretreatment program.

All industrial users within the area served by VCWRF are periodically surveyed. Significant industrial users are identified and issued wastewater discharge permits that limit substances that enter the sewer system. These industries are monitored and inspected both on a routine and random schedule.

Wholesale Customer Metering

All 23 communities served by VCWRF are flow-metered with remote polling into computer databases. Rain gauges have been installed at several of the metering locations to determine how wastewater flow rates are affected by rainfall. Staff members have portable flow meters and other instrumentation to determine accuracy and reliability for future capital outlay request.

Metering Station and Equipment