Southwest Clean Water Plant

City of Springfield, Missouri

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THE SOUTHWEST CLEAN WATER PLANT

The Southwest Clean Water Plant is located where Wilson's Creek and South Creek join together. The plant is a combination of the old treatment plant, Plant #1, whose operation began in 1959 with a flow capacity of 12 million gallons per day, and three major upgrades. An expansion and major upgrade was completed in 1978 which increased the capacity to 30 million gallons per day. Higher levels of treatment were also achieved at this time. Further expansion and major improvements were dedicated in 1993 with the addition of a second treatment train, Plant #2. Other major construction phases involved the further enhancement of the 1993 expansion to include biological removal of phosphorous followed by the addition of chemical phosphorous removal for the 1978 expansion. New biosolids handling improvements were instituted along with the construction of a 1.2 million gallon biosolids storage tank. Other construction included the refurbishment of the 1973 filters which included the addition of biological nitrogen removal. The most recent expansion was the addition of two 165' diameter primary clarifiers, a new pumping station, and biofilter odor control. Also included was the addition of two new final clarifiers for Plant #2

The combination of these four phases of construction is now capable of continually treating 42.5 million gallons per day of Springfield's wastewater and 100 million gallons per day for shorter periods. The average daily flow at this time is approximately 35 million gallons per day. The plant is designed to produce an effluent which can be discharged into Wilson's Creek without damage to the river water quality.

The plant is staffed 24 hours per day 365 days per year by a staff of 45 operations, maintenance, and laboratory personnel. The plant removes approximately 70,000 pounds of pollutants from the wastewater per day before it is discharged.

The treatment plant consists of the following major process units:

Influent Structure

The first step is to remove debris, sand, and gravel which are present in the wastewater stream. Material like this would ruin machinery in the plant if not removed. Removal is accomplished in a covered influent facility. The wastewater enters the plant through a structure called a trash rack. This consists of a series of parallel ½ inch steel bars spaced at three inches. This rack physically screens out larger material such as pieces of broken pipe, larger rocks, and similar material.

Next the wastewater passes through four automatic bar screens. These, much like the trash rack, physically screen out material referred to as "rags". The openings in the bar screens are 3/8 of an inch.

The next step is grit removal, which is the removal of sand and gravel. This is accomplished in an aerated grit chamber. The velocity of the wastewater is reduced to approximately 2 feet per second. This causes the grit, carried in the wastewater, to fall to the bottom of the tank where it is removed. All of these materials are transported to Springfield's Sanitary Landfill for environmentally safe disposal. Any material that floats is also removed in the head works by a skimming process. This consists mainly of solid grease and oils and is referred to as scum. This material is pumped to the anaerobic digesters.

Primary Clarifiers

Additional mechanical treatment occurs in the primary clarifiers were larger insoluble material is allowed to settle out. This material is then removed by utilizing large mechanical scrappers which continually remove the primary sludge from the bottom of the clarifiers to pumps which transfer the material to the anaerobic digesters. This process allows the two plants to more efficiently treat the incoming wastewater. The primary clarifiers can also act as large flow equalization basins in the event of unnaturally heavy flow situations.

Flow Equalization System

At times the flow entering the plant is higher than 42.5 million gallons per day, the peak capacity of the plant. Under these circumstances 42.5 million gallons per day receive full treatment while the remainder flows into equalization basins. These basins combined are capable of holding 41 million gallons. When they become full, the excess diluted wastewater flow is treated in a peak flow clarifier and discharged to the creek.

Activated Sludge Process

Activated sludge treatment is the most important part of our wastewater treatment plant. Wastewater from the influent structure is split between two biological treatment systems according to each systems capacity. The processes are similar in nature as they both employ microorganisms to remove organic matter, both suspended and dissolved, from the wastewater stream. In addition, ammonia is changed to nitrate. Examples of the microorganisms are bacteria, flagellates, rotifers, and a host of other similar organisms. Conditions in the aeration and pure oxygen tanks are carefully adjusted to produce an ideal environment for the growth and proliferation of these simple animals.

After these microorganisms are produced they must be removed from the wastewater before it goes on to the next treatment process. This is accomplished in large settling tanks called clarifiers. The microorganisms settle to the bottom of the clarifiers where they are drawn off. Most of them are recycled back to the aeration or oxygen tanks unless their concentration has become too great. In this case, they have to be removed from the system. The Southwest Plant produces approximately 16 dry tons of these biosolids per day.

Phosphorus Removal

Phosphorus is removed in the activated sludge process of Plant #2 when the microorganisms are subjected to an anoxic/anaerobic zone or area devoid of oxygen that contains food material. This stresses a certain type bacteria present in the process and causes them to release stored phosphorus. When they return to the oxygen rich area of the plant they take in more phosphorus than they released. This results in a lower concentration of phosphorus in the water leaving the plant. Conditions must be carefully controlled for this process to take place.

Biological removal of phosphorus is not applicable to Plant #1 because of process differences. In this plant phosphorus is removed by addition of aluminum sulfate. The aluminum combines with phosphorus to form an insoluble material that is removed with the waste biosolids.

Polishing Filters

The polishing filters are the next process and are used to remove any remaining suspended solids from the wastewater. The filtration media is sand in the new system and mixed media in the old system. As suspended solids are removed from the wastewater and the filter becomes dirty the water cannot flow through the filter as fast. The filter must then be cleaned by forcing finished water through from the bottom up which washes the solids out of the filter. The dirty backwash is pumped to the head of the plant for retreatment.

Ozone Disinfection

The flows from the two treatment systems come together again for the last step in the treatment process, disinfection. Ozone which is produced on site is used as the disinfection agent. The process takes place in the covered ozone contact tank, where a mixture of oxygen and 3 % ozone is rapidly mixed with the wastewater in order to dissolve the Ozone into the water. Ozone is a very effective disinfection agent and has the added benefit of breaking down chemically into oxygen. This, along with the dissolved oxygen from contact with the oxygen atmosphere produces a finished water with high dissolved oxygen. The finished water is clear, colorless, non-polluting, odor free water which can be safely discharged into Wilson's Creek.

Ozone Generation

The production of ozone consist of two stages. The first stage is to produce the pure oxygen. This is done by compressing, cooling and liquefying air, removing contaminates, and distilling the liquid to separate nitrogen from the oxygen. Both liquid and gaseous oxygen with greater than 95% purity can be produced. The liquid oxygen is stored in two 25,000 gallon tanks for use when gaseous oxygen cannot be produced. The oxygen generation plant can produce 50 tons of oxygen per day. The second stage is the production of ozone. This is done by feeding the gaseous oxygen to the ozone generators. The ozone is produced by passing the pure oxygen through an electrical discharge. This electrical discharge is passed between metal mesh through which the oxygen gas is fed. This process converts 3% of the oxygen to ozone. The oxygen and ozone mixture is fed to the ozonation tanks for disinfection.

Biosolids Handling

The solids removed from the Southwest Plant are processed and recycled in the following manner.

Sludge Thickening

The sludge or waste microorganisms from the activated sludge biological treatment processes are first pumped to devices called gravity belt thickeners. In this process the waste sludge which is about 1 % solids is coagulated with water soluble polymers. The coagulated solids are then conveyed along a porous belt allowing separation of the solids from the free water. This produces biosolids of approximately 5% total solids.

Anaerobic Digestion

The next step is anaerobic digestion. This is accomplished by employing microorganisms in the absence of oxygen in million gallon covered tanks called anaerobic digesters. Conditions are carefully controlled in order to produce an environment where anaerobic biological activity can flourish. This breaks down solids reducing their concentration by about one-half. This process results in the sludge being transformed into an inoffensive humus type of substance which can be safely spread on land for soil conditioning and fertilization. Thus, the waste materials from the treatment processes are beneficially reused and recycled in an environmentally safe manner.

The process results in the generation of methane gas, a valuable source of energy. The methane gas is used as a fuel for large engine driven plant equipment and to produce building heat, reducing the use of electricity and other fuels.

Another pathway for sludge disposal is to dewater the digested sludge using high speed centrifuges. This is done when weather conditions make it undesirable to take liquid sludge to field. Again using polymers to aid in dewatering, the digested sludge is taken from 3% solids to 23% solids. This material is then stockpiled until such time that it can be beneficially reused on fields much like the liquid digested sludge.

All treatment processes are continuously monitored through a program of sampling and testing by our laboratory. Our laboratory staff of five Biologists and Chemists run over 5,500 samples per month to ensure that all Federal and State standards are met by the facility.

Typical Plant Performance

Parameter	Raw Wastewater		Plant Effluent	
Biochemical Oxygen Demand	260	mg/l	<2	mg/l
Total Suspended Solids	245	mg/l	<2	mg/l
Ammonia Nitrogen	15	mg/l	<0.1	mg/l
Dissolved Oxygen	0.0	mg/l	>20	mg/l
Total Phosphorus	8	mg/l	<0.5	mg/l
Fecal Coliform Bacteria	>1,000,000	per 100 ml	< 10	per 100 ml
Whole Effluent Toxicity Test	N/A			Pass
pH std. units	7.4	std. units		7.10
Copper	80	ug/l	15	ug/l
Chromium	16	ug/l	<10	ug/l
Zinc	1300	ug/l	40	ug/l
Cadmium	<5	ug/l	<5	ug/l
Lead	<20	ug/l	<20	ug/l
Nickel	25	ug/l	<10	ug/l
Mercury	0.32	ug/l	<0.2	ug/l
Silver	6	ug/l	<5	ug/l
Arsenic	<20	ug/l	<20	ug/l
Cyanide	<10	ug/l	<10	ug/l
Total Toxic Organics	Some Above Detection		Below Detection Limits	

UTILITY STATISTICS

COLLECTION SYSTEM

LENGTH	6 MILLION FEET OR 1200 MILES.
PIPE SIZES	8 INCHES THROUGH 60 INCHES.
CAPACITY	PEAK FLOW TO 120 MGD, AND AVERAGES A TOTAL OF 13 BILLION GALLONS PER YEAR.
PUMP STATIONS	25 TOTAL
JAMES RIVER PUMP STATION	PEAK CAPACITY OF 25 MGD AND AVERAGES A TOTAL OF 2.0 BILLION GALLONS PER YEAR.

SOUTHWEST TREATMENT PLANT STATISTICS

DESIGN CAPACITY

AVERAGE DAILY FLOW 42.5 MGD.

PEAK FLOW 65 MGD FULL TREATMENT.

BOD & SUSPENDED SOLIDS INFLUENT - 200 MILLIGRAMS PER LITER.

EFFLUENT - 5 MG/L MILLIGRAMS PER LITER.

AERATION BASINS

FOUR	180 x 45 x 10.5	FOOT	PURE OXYGEN BASINS.
TEN	140 x 25 x 13	FOOT	NITRIFICATION BASINS.
FOUR	132 x 132 x 15	FOOT	EXTENDED AERATION BASINS.

CLARIFIERS

TWO	165 x 12	FOOT	DIAMETER PRIMARY CLARIFIERS
P1 FOUR	110 x 12	FOOT	DIAMETER SECONDARY CLARIFIERS
P2 TWO	135 x 12	FOOT	DIAMETER SECONDARY CLARIFIERS
P1 THREE	122 x 12	FOOT	DIAMETER FINAL CLARIFIERS.
P1 FIVE	51 x 51 x 12	FOOT	FINAL CLARIFIERS.
P2 FOUR	110 x 12	FOOT	DIAMETER FINAL CLARIFIERS.

POLISHING FILTERS

EIGHT	867 SQ. FT.	DENITRIFICATION FILTERS.
FOUR	16 x 90 x 9	FOOT TRAVELING BRIDGE BACK WASH FILTERS.

DISINFECTION

NINE 34 x 34 x 8 FOOT OZONE CONTACT BASINS, 20 MINUTE DETENTION TIME.

BIOSOLIDS THICKENING

TWO 2 METER GRAVITY BELT THICKENERS

ANAEROBIC DIGESTERS

FOUR 80 FOOT DIAMETER PRIMARY DIGESTERS, 20 DAY DETENTION TIME, WITH EXTERNAL DRAFT TUBE MIXERS.

ONE 90 FOOT DIAMETER BIOSOLIDS STORAGE TANK.

SLUDGE DEWATERING

THREE 230 GPM, 3450 LB SOLIDS PER HOUR HIGH SOLIDS CENTRIFUGES WITH POLYMER CONDITIONING

GENERAL OPERATING STATISTICS FOR THE SW TREATMENT PLANT

APPROXIMATE FLOW PER YEAR	12 BILLION GALLONS
AVERAGE FLOW PER DAY	35 MILLION GALLONS
SOLIDS PROCESSED PER YEAR	6000 DRY TONS
AVERAGE LABORATORY TEST PER YEAR	70,000 TESTS

* MGD = MILLION GALLONS PER DAY
* GPM = GALLONS PER MINUTE