

## Description of the Water Conserv I Facility

### *Introduction*

The Water Conserv I (WCI) facility has a design capacity of 7.5 mgd and is classified by FDEP as a Class A, Level 1 treatment plant. The facility is designed to service about 75,000 people. This volume of flow is equal to about 136,400 55 gallon drums! The WCI facility was built to protect the Central Florida environment, especially in Orange County, with its "Zero Discharge" method of effluent reuse/recharge. The highly treated effluent is utilized throughout the Orlando International Airport area as reuse water, and recharges the surficial aquifer by means of Rapid Infiltration Basins. The benefit of the Water Conserv I plant, as well as each of the City of Orlando's Water Reclamation facilities, is equal to its goal ... to ***preserve the environment*** and to ***protect public health***. This is also in harmony with the City of Orlando's mission ... "***Serving Orlando with Innovation, Responsiveness, Knowledge, Professionalism and Courtesy.***"

The Water Conserv I facility was designed with the following influent loadings:

<b>Parameter</b>	<b>Design Data</b>
Average Daily Flow	7.5 mgd
INF BOD <sub>5</sub>	250 mg/l ... 15,700 lbs/day
INF TSS	220 mg/l ... 13,800 lbs/day

INF TN 34 mg/l ... 2,100 lbs/day

INF TP 13 mg/l ... 800 lbs/day

### ***Process Overview***

The liquid process stream includes screening removal, grit removal, primary clarification, activated sludge process with fine bubble diffused aeration, secondary clarification and RAS pumping, denitrification basins, final clarification and RAS pumping, effluent filtration, and high level disinfection using chlorine.

The solids process stream includes DAF sludge thickening, anaerobic digestion, belt filter press dewatering, and land application of Class "B" biosolids.

### ***Facility Flow Pattern Description***

#### ***Liquid Flow Stream***

Raw wastewater enters the headworks where it passes through fine bar screens and then a forced vortex grit removal system. Screenings removal provides protection to downstream pumps, pipes, and valves from plugging with debris. Grit removal provides protection of those same components from erosion and premature wear; also, grit removal minimizes sand from accumulating in the downstream tanks and maintains the valuable capacity within the tankage. The screened and degritted raw wastewater then flows through a Parshall Flume channel to the aeration tanks. Before entering the aeration tanks, the raw wastewater is premixed with the return activated sludge from the secondary clarifiers; the combined mixed liquor then enters the beginning of the aeration basins. Also, prior to RAS introduction, raw wastewater can flow to and from the EQ tank for flow equalization.

### ***AWT Processes***

#### ***Aeration - Nitrification***

The nitrification process includes aeration tanks with fine bubble diffusers, secondary clarifiers, return activated sludge (RAS) pumping, and waste activated sludge (WAS) removal. The aeration system accomplishes complete nitrification (the conversion of ammonia-nitrogen to nitrate-nitrogen) in a high dissolved oxygen environment. Nitrified mixed liquor leaving the aeration tanks enters the secondary clarifiers for separation and settling. Due to complete nitrification and high D.O.'s in the aeration tanks, nitrate-nitrogen levels in the mixed liquor entering the secondary clarifiers is quite high (possibly between 15 to 20 mg/l).

Settled solids within the secondary clarifier, known as sludge blanket, is withdrawn on a continuous basis for return to the beginning of the aeration system. This is known as return activated sludge (RAS) and represents the process microorganisms in a concentrated form. The clear liquid overflowing the clarifier weirs is called secondary effluent and is conveyed downstream to the anoxic denitrification tanks. Before the secondary effluent enters the anoxic tanks, a solution of methanol is introduced into the flow stream ... then, RAS from the final clarifiers is introduced into the flow stream. The methanol provides a pure source of carbon (food) for the denitrifying microorganisms, while the nitrates provide the oxygen source. This is known as chemically-enhanced denitrification.

### **Capital Cost of the Water Conserv I Facility**

<b>Year</b>	<b>Size</b>	<b>Dollars</b>
1987	7.5 mgd	\$85 Million

This capital cost also included collection system interceptors.

**Water Conserv I  
Water Reclamation Facility  
Annual O&M Budget - 1996**

**\$3.9 Million**

The belts then move past the scrapers to wash boxes where the belts are cleaned. The belt cleaning system is designed to remove sludge which may have been forced into the pores of the belt weave by the pressure rollers and scraper blades. As the belts are cleaned of sludge, they are ready to begin the process over again. If the belts are not cleaned properly, belt "blinding" may occur and the overall belt press performance will suffer.

***Facility Permit Requirements***

Parameter	Permitted Limit
Permitted Flow Capacity	7.5 mgd
<i>Effluent Permit Limitations</i>	
CBOD5	20 mg/L
TSS for Reuse - before disinfection	5 mg/L
TSS for RIBS	10 mg/L
Fecal Coliform	Less than 1 per 100 ml (no more than 25 per 100 ml in any given sample)
pH	6.0 to 8.5
Total Chlorine Residual - Reuse	No less than 1.0 mg/L after 15 minutes D.T. @ peak flow

Total Chlorine Residual - RIBS	No less than 0.5 mg/L after 15 minutes D.T. @ peak flow
Turbidity - before disinfection	Less than 2.0 NTU

Denitrified mixed liquor leaves the anoxic tanks and is mixed with a solution of aluminum sulfate (alum) before it enters the final clarifiers. The alum addition accomplishes phosphorus removal where the phosphorus is chemically bound in the sludge. The phosphorus is ultimately removed from the process in the final waste activated sludge (WAS) stream.

Settled solids within the final clarifier, known as sludge blanket, is withdrawn on a continuous basis for return to the beginning of the anoxic system. This is known as return activated sludge (RAS) and represents the denitrifying microorganisms in a concentrated form. The clear liquid overflowing the clarifier weirs is called tertiary effluent and is conveyed downstream to the deep bed effluent filters. From here, the effluent is disinfected and pumped to the irrigation system or to the rapid infiltration basins.

### ***Alternate Mode of Operation for Biological Nutrient Removal***

Experience has shown that partial biological nutrient removal can be achieved without the use of chemicals. In this mode of operation, the first  $\frac{1}{2}$  of each aeration tank is operated with just enough air to provide mixing, but very little oxygen transfer takes place. This is confirmed by the low D.O. obtained in the first and second grids of the tank (D.O. remains as close to zero as possible). In this oxygen-starved zone a few conditioning activities are occurring; first, the initial anoxic environment promotes denitrification of the nitrates in the mixed liquor carried in the RAS stream, then, once the nitrates are low and unavailable for a source of oxygen, probably about one to two hours into the tank detention time. This long detention time with low-to-no dissolved oxygen creates a condition in the microbiology recently referred to as an "oxygen block." It is believed that the oxygen block environment allows denitrification to occur in the downstream aerobic zone (even at higher D.O.'s). Ammonia remains untouched in the anoxic/fermentation zone (no nitrification).

The denitrified and conditioned mixed liquor flows into the aerobic portion of the tank ... the last ½ to ¾ of each aeration tank. Here, air is added and oxygen is dissolved; D.O. is maintained between 1.5 to 2.5 ppm, possibly higher at times. Many nutrient removal activities take place in this aerobic zone. Theoretically, these activities are occurring simultaneously and include nitrification, denitrification, and, possibly, luxury Bio-P uptake.

In the aerobic zone, nitrification converts ammonia to nitrites and then to nitrates. Also, occurring simultaneously, is the conversion of nitrates to free

nitrogen gas (denitrification). Denitrification in a fairly high D.O. environment (up to about 2.5 or 3.0 ppm) **IS NOT CONSIDERED TO BE A NORMAL ACTIVITY**. The recent studies in the BNR field hold a new theory about this activity and refer to it as "Aerobic Denitrification", which is

Before the sludge enters the inlet feed pipe of each belt filter press, it passes through a polymer dosing ring and an in-line venturi mixer. During this inlet sludge-polymer conditioning process, the sludge is mixed with a solution of polymer and allowed to react for 15 to 45 seconds to form a floc. The conditioned floc is actually "clumps of sludge" which have formed through the electrostatic action of the polymer. This conditioning process produces a large volume of free, unbound water.

The conditioned sludge is applied to the top belt of the press by way of the feed chute. This gravity section allows physical separation and drainage of the water from the sludge. Water drains through the porous weave belt, into the support grating and onto the drainage collection pans. As the sludge moves on the belt, it is turned over by distributor devices known as chicanes.

The chicanes increase gravity dewatering by turning the sludge and creating a windrow effect which clears spaces on the belt allowing unbound water to drain through the porous belt. The sludge is prevented from running off the sides of the belt, in the gravity zone, by side retaining plates with rubber neoprene seals. At the completion of the gravity dewatering zone, the sludge is a loosely structured cake with a total solids content of about 6% to 8%.

The second filtration stage of dewatering (pressure and shearing) takes place as the loosely structured cake is compressed between the bottom belt, which the sludge is laying on, and the top belt which forms a wedge. As the sludge enters this wedge zone it is compressed and additional water is forced out, much like compressing a wet sponge. This water can be seen coming through the upper and lower belts.

By the time the sandwiched cake leaves the first roller, the sludge next to the one of the following application points throughout the treatment process: belt

is dewatered and very compact. However, this results in the sludge in the middle of the cake remaining wet due to water being trapped between the outer cake layer, which is dry and compressed. This is the main purpose for the sludge to pass through additional rollers. The additional rollers create a shearing motion between the two belts rearranging the sludge mass which exposes the wet inner cake to the belts allowing more water to be released from the sludge.

When the cake reaches the end of the shearing section, it has been sufficiently turned over to release nearly all of the free water from the sludge. At the last shearing roller the belts separate, the sludge cake is removed from the belts by doctor blade scrapers, and the cake then dropped onto a conveyor for loading into the trucks.

## **Anaerobic Digestion**

One or both digesters can receive sludge from the following sources:

1. Primary sludge from the primary clarifiers.
2. Thickened waste activated sludge from the DAF process.

The feed sludge can enter either digester directly, or it can first flow through the external heat exchanger and then enter the digester. The external heat exchanger is designed to: 1) Increase the temperature of the incoming sludge, 2) Mix the incoming sludge with the recirculated sludge from the digester, and, 3) Maintain the digester contents at a predetermined, stable temperature.

Depending on the mode of operation for digester feeding, each digester can be recirculated from the tank to the external heat exchanger and then back to the tank. This is designed to equally distribute the mixture of sludge and the temperature of the sludge. Sludge recirculation alone does not provide much mixing of the digester contents. Actual mixing of the tank is accomplished with the gas mixing system.

Digester gas is withdrawn from the dome of the tank, conveyed to the gas compressors and then returned to the tank through bubble gun mixers. Each tank has six bubble gun mixers to accomplish tank mixing. Excess gas is burned off in the waste gas burners.

Sludge is transferred from No.1 digester to No.2 digester with a pumping system that is automatically activated by a level control system. Sludge to the transfer pumps is received from the inlet lines to the recirculation pumps.

Digested sludge, normally from the secondary (No.2) digester, is conveyed to the belt press feed pump, using the inlet lines to the recirculation and transfer pumps.

Digested sludge, normally from the secondary (No.2) digester, is conveyed to the belt press feed pump, using the inlet lines to the recirculation and transfer pumps.

Digester heating can be accomplished two ways: 1) From the internal heat exchangers inside of the digesters (each mixing gun has a wrap-around heat exchanger), and, 2) From the external heat exchanger. Hot water is generated and recirculated from a hot water boiler and hot water recirculation pumps.

### **Belt Filter Press Dewatering**

Sludge feed to each belt press is withdrawn from the anaerobic digester with a variable speed sludge feed pump. Each sludge feed pump has a magnetic flow meter on the discharge line of the pump for flow monitoring purposes.

a result of the "oxygen block" developed by the microorganisms. The oxygen block theory states that the denitrifying microorganisms will use nitrates as a source of oxygen (denitrification), in a high aerobic environment, at the same time the nitrifiers are using free dissolved oxygen for the conversion of ammonia (nitrification). Theoretically, this happens because the microorganisms were conditioned for an extended period in an oxygen deficient environment prior to entering the high oxygen zone. In this manner, the microorganisms have developed a "block" for the proprietary use of the free oxygen (D.O.) and different groups of microorganisms are using nitrates and oxygen for various activity purposes at the same time.

As the mixed liquor leaves the end of the aeration tanks, it travels through the collection channel and enters the secondary clarifiers. The mixed liquor should have a low ammonia

concentration (between zero to 1.0 ppm), the nitrates are between 2 to 4 mg/l, and the phosphorus will be biologically bound in the bug bodies with a concentration of about 1.0 to 2.0 ppm (maybe a little lower, maybe a little higher). It appears that Bio-P uptake is greatly affected by the process F/M ratio. Generally, higher F/M ratios result in improved luxury uptake of Bio-P.

Settled sludge in the secondary clarifiers is removed continuously and returned to the beginning of the aeration tanks as RAS. A portion of the RAS is removed from the system as WAS where it is thickened in the DAF process, then stabilized in the anaerobic digestion process, then dewatered in the belt filter press process, and then ultimately disposed of by land application.

The clarified effluent overflows the weirs and is conveyed to the downstream processes where filtration, disinfection, reuse and disposal take place.

### **Chlorination System**

The chlorination system at Water Conserv I consists of ton containers with the pigtailed connected to the gas valves. An automatic switchover unit is controlled by system regulators and activated by system vacuum. Chlorine gas is drawn into vacuum chlorinators, each with its own gas injector. The gas outlet line from each chlorinator can be interconnected to any one of the gas injectors. The chlorine solution from the injectors can be interconnected to any one of the following application points throughout the treatment process:

- EQ Tank Inlet
- EQ Tank Odor Control System
- Primary Process Odor Control System
- Primary Clarifiers Inlet
- Effluent Filters
- Chlorine Contact Chamber
- Effluent Holding Tank

### **Effluent Release**

As mentioned, the effluent is utilized as reuse water at various locations around the Orlando International Airport. Also, as a means of effluent release, a series of 19 RIBS are used to recharge the surficial aquifer.

### ***Solids Handling Flow Stream***

#### **Dissolved Air Flotation (DAF) Sludge Thickening**

Waste activated sludge (WAS) originating from the secondary clarifiers and the final clarifiers is thickened in the DAF units. WAS enters the DAF system through an 8 inch line where it is mixed in the DAF inlet line with a pressurized recycle stream. This mixture enters the DAF tank through a manifold that distributes the combined flow to four reaction jets. The jets provide an even distribution of the inlet sludge feed into the thickener.

Recycle water, which is subnatant from the DAF process, is saturated with air in the pressurization tank as compressed air is dissolved into water under pressure. The pressurized flow passes through a backpressure valve and then to the inlet reaction jets. As the sludge/recycle mixture flows into the thickener, air bubbles come out of solution due to the drop in pressure. The air bubbles attach themselves to sludge particles and rise to the surface of the thickener, creating a floating blanket of thickened sludge.

A float blanket of about 18 to 24 inches is maintained on the surface of the DAF tank. The float sludge is moved by the skimmer system to the sludge trough at the outlet end of the thickener where it is conveyed to the thickened sludge wet well by a cross screw conveyor. Thickened sludge is withdrawn from the wet well with thickened sludge pumps and discharged to the Anaerobic Digestion process.

Bottom sludge that settles to the floor of the DAF tank is scraped into two hoppers at the inlet end of the tank. From here, the settled sludge is removed from the tank with the thickener underflow pump and discharged into the thickened sludge pumps discharge line. The combined thickened sludge is measured by the system magnetic flow meter.

The excess thickener overflow water (subnatant) leaves the DAF by flowing under the sludge retention baffle and over the tank weir where it enters the 8 inch overflow line. The subnatant flows to the process drainage pump station where it is pumped into the influent equalization tank for re-treatment in the plant.