ENVIRONMENTAL
ENGINEERING & CONTRACTING, INC.
501 Parkcenter Drive, Santa Ana, CA 92705
Phone (714) 667-2300 Fax (714) 667-2310
www.eecworld.com

Technical Memorandum

Date:	December 21, 2011
From:	EEC, Inc.
To:	Thermaco, Inc.
Subject:	Evaluation of Packaged Wastewater Treatment Systems in Mexico City, Mexico
Project:	W-2336.01

This technical memorandum summarizes the observations and evaluation of four packaged wastewater treatment systems (WWTSs) in Mexico City, Mexico.

1. Introduction

Environmental Engineering & Contracting, Inc. (EEC) was retained by Thermaco, Inc. (Thermaco) to evaluate the efficiency of Thermaco's Trapzilla® units that have been installed in several packaged Wastewater Treatment Systems (WWTSs) in Mexico City and to observe the relatively new progress in water conservation by private companies.

The WWTSs, which are owned by Wal-Mart de México and Central America (Wal-Mart), are installed at several retail stores. The purpose of these WWTSs is to treat sanitary waste, vegetable rinse water, meat and food processing wastewater at each store and reuse the treated water within the same store. The treated water, which is reused for irrigation and toilet flushing, helps reduce the stores fresh water demands.

Wal-Mart owns 1,932 retail units in Mexico and is planning to install WWTSs at the majority of the retail stores. In the first half of 2011, Wal-Mart saved more than 140 million gallons of water, and treated 25% of its water consumption for reuse within its stores in Mexico and Central America (Wal-Mart's website, statement posted in August 2011). Wal-Mart outsources design, installation and operation of the WWTSs. Acuanovus, a local engineering and consulting company, is one of the Wal-Mart's contractors that designs, installs, operates and maintains several of Wal-Mart's WWTSs. To date, the company has designed and installed 30 WWTSs and is contracted to install another 30 WWTSs at the Wal-Mart retail stores in Mexico. During EEC's visit, four of the WWTSs that have been designed, installed and in operation by Acuanovus were visited on November 9-11, 2011.

EEC's observations, comments and recommendations are presented in the following sections. The detailed descriptions of individual WWTSs are presented in the Appendix Section.

2. Wastewater Practices in Mexico City

Fresh water consumption in the Mexico City metropolitan area with a population of over 20 million is approximately 1,650 million gallons per day (MGD). Groundwater comprises approximately 70% of the water supply while surface water from Lema Basin and Cutzamala System comprises the remaining 30%. As the surface water supply has been decreasing, the groundwater extraction has been increasing.

Since 2009 the government has launched many water saving campaigns encouraging the public to save

water. However, the water savings in the urban areas may not have a significant impact on water conservation as the urban water use is only 10% as opposed to 75% water use by industry, commercial and agricultural accounts. Currently, there are 23 wastewater treatment plants in Mexico City with a combined treatment capacity of 94 MGD. By 2012, it is expected that the treatment capacity will increase to 119 MGD. As the main concern is insufficient recharge of the groundwater basins, recent regulations are attempting to shift wastewater treatment responsibilities to water users.

3. Wastewater Treatment Processes

The WWTSs installed at Wal-Mart retail stores provide secondary treated wastewater in compliance with the Mexican recycled water quality standards described in Section 3. The design of the WWTSs has been modified and optimized several times. The modifications and optimization are referred to as G4 or G3 Systems (with G referring to Generation). The key upgrades between G4 and older G3 Systems include a smaller footprint, more efficient aeration, and free flowing biomass carriers (AGAR®) rather than fixed activated sludge treatment (MicroFAST®). Table 1 lists the WWTSs visited by EEC during November 9-11, 2011.

Table 1 – Wastewater Treatment Systems Visited by EEC in Mexico City

Store Name	WWTS Footprint m^2	WWTS Design Capacity m^3/d	System Model	Trapzilla® Units	Influent BOD mg/L	Target Effluent BOD mg/L
Superama La Joya	55	26 (4.8 gpm)	G4	2	>60,000	20-30
Superama Ajusco	34	26 (4.8 gpm)	G4	2	>1,800	20-30
Superama Dakota	45	26 (4.8 gpm)	G4	2	>1,100	20-30
Bodega AurreraTepotzotlan	78	42 (7.7 gpm)	G3	4	>1,800	20-30

The oldest WWTS (Bodega Aurrera Tepotzotlan, Figure 1) is a G3 System and has been in operation since 2008. The newest WWTS (Superama La Joya) is a G4 System and a newly constructed plant. The descriptions and photos of the WWTSs are included in the Appendix Section (Appendix 1-4).

Figure 1 - Bodega Aurrera Tepotzotlan WWTS

In general, the treatment processes include primary sedimentation, biological treatment and disinfection as described below and shown in Figure 2.

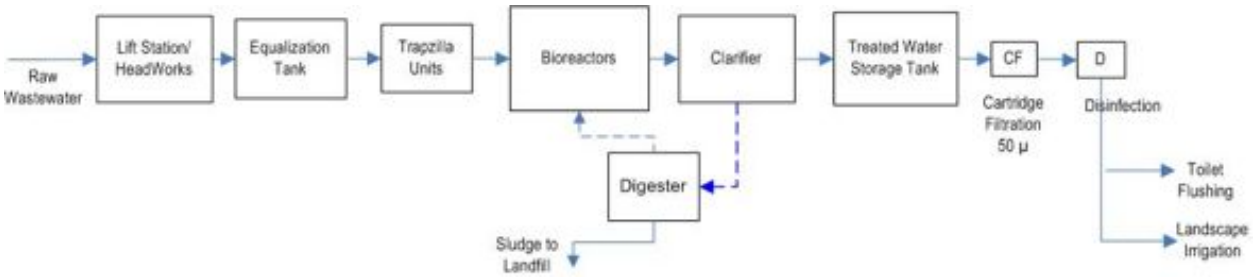

Figure 2 – General Treatment Process Flow Schematic

Lift Station/ Headworks

The raw wastewater is a blend of sanitary waste and wastewater generated from vegetable and meat rinsing as well as food preparation activities. It is collected in a lift station and pumped to an equalization tank. Large debris, such as rags, is shredded into smaller pieces by the grinder pumps (Vaughan® submersible chopper pumps).

Primary Treatment

Trapzilla® units configured in series function as sedimentation basins and remove debris and particulate matter from the wastewater. The first Trapzilla® unit is used for sedimentation and the second unit is used for fat and grease removal as shown in Figure 3.

Figure 3 – Trapzilla® Units in Series

Secondary Treatment

The secondary treatment including biological treatment and nutrient removal takes place in one or two aeration tanks (bioreactors) depending on the system generation (the G4 System has two bioreactors in

series whereas the G3 System has one large bioreactor). The majority of Biological Oxygen Demand (BOD) and organic carbon are removed in the bioreactors

The current installations (G4) include two bioreactors designed as AGAR® (Attached Growth Airlift Reactor) (proprietary design by Aqwise). AGAR® includes free flowing packed media (biomass carriers). Air supplied by blowers ensures airlifting and circulation of the biomass carriers1. Biomass carriers are free flowing media made of high density polyethylene with a 650 m^2/m^3 surface area. The quantity of the biomass carriers is calculated based on the biological loads. The figures below illustrate biomass carriers, a bioreactor with free flowing media and a bioreactor with MicroFast®.

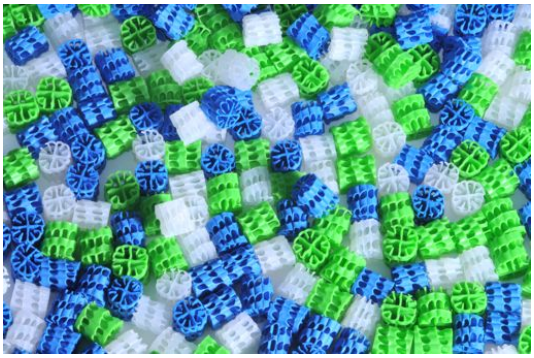

Figure 4 – Free Floating Biomass Carriers

Figure 5 – Top View of A Bioreactor with Free Floating Biomass Carriers

1 The MicroFAST® (Fixed Activated Sludge Treatment) used in G3 Systems includes a hybrid combination of attached and suspended growth in an aerobic packed bioreactor. The system requires more air supply and a larger footprint.

Figure 6 – Top View of A Bioreactor with MicroFast®

Subsequently, suspended solids and some BOD are removed in a clarifier that contains large packed media (at least four times larger than the biomass carriers) as illustrated in Figure 7.

Figure 7 – Top View of the Clarifier at Superama Dakota WWTS

Disinfection

The effluent from the clarifier is stored in a treated water storage tank. The treated water is filtered through a 50 micron (m) cartridge filter and chlorinated using chlorine tablets prior to reuse for toilet flushing and landscape irrigation. A blue dye is also added to the disinfected treated water used for toilet

flushing in order to distinguish between the recycled water and fresh water. A minimum chlorine residual of 1.5 mg/L is required in the recycled water used for toilet flushing. The recycled water used for irrigation is spread over the landscaping areas surrounding the store.

Biosolids

Sludge from the clarifier is pumped to a digester. The sludge is usually aerated to prevent odor formation and frequently pumped out of the digester and hauled off to a landfill as required. The supernatant is returned to the bioreactors.

Operations and Maintenance

A full time operator is responsible for operation and maintenance (O&M) of each WWTS which operates 16 hours a day. The plant operator manually cleans the Trapzilla® units on a daily basis or every other day. As the pump out option (FOG removal by pumpers) is not available in Mexico City, regular maintenance of the units mitigates any potential odor and vector issues.

Solids and grease removed from the Trapzilla® units are collected in a trash bag and discarded in a garbage bin along with other trash. Manual cleaning of bioreactors and the digester tank is required every 3 to 12 months. When the plant is in the maintenance mode, the system is shut down and potable water is used for irrigation and toilet flushing.

4. Recycled Water Quality Requirements in Mexico

The wastewater is treated in accordance with the recycled water quality requirements; Class A or Class B. The recycled water quality parameters include BOD, Total Suspended Solids (TSS), Oil and Grease (O&G), Fecal Coliform and Helminthes eggs. There are no permit limits for pH and Chemical Oxygen Demand (COD). Table 2 includes the Class A and Class B recycled water quality requirements.

Table 2 – Class A and Class B Recycled Water Quality Requirements

Parameters	Maximum Permitted Values		
	Unit	Class A	Class B
pH	Standard Unit	No Limit	No Limit
COD	mg/L	No Limit	No Limit
BOD	mg/L	20	30
TSS	mg/L	20	30
O&G	mg/L	15	15
Fecal Coliform	MPN/100 mL	240	1000
Helminthes Eggs	eggs/L	≤1	≤5

MPN: Most Probable Number

Helminthes Eggs: Helminthes eggs are parasite worms or infective agents for the types of worm diseases known globally as helminthiases.

5. Recycled Water Quality Requirements in California

The State of California is the leading state in the United States (US) in regulating and controlling the use and quality of the recycled water. Recycled water has been used in the State of California since the early 1930's. The California Department of Public Health (CDPH) is the responsible regulatory agency that oversees the use of recycled water under California Code of Regulations (CCR) Title 22 and Title 17. CCR Title 22 ensures consistent, reliable water quality while protecting public health and establishes the requirements for recycled water treatment, quality, and allowable use. CCR Title 17 controls cross connection potentials and back flow prevention measures.

High quality tertiary disinfected recycled water is used for the surface irrigation of food crops, including all edible root crops and where the recycled water comes into contact with the edible portion of the crops as well as recycled water used for toilet flushing. Tertiary disinfected recycled water refers to a filtered and subsequently disinfected wastewater that meets the criteria listed in Table 6.

Table 6 – CDPH Disinfected Tertiary Recycled Water Requirements

Parameter	Value
Turbidity	2 NTU Average
Turbidity	5 NTU not more than 5 percent of the time during 24-hour period
Turbidity	Less than 10 NTU at all times
Total Coliform Bacteria	2.2 MPN per 100 mL per sample, median reading not to exceed over any 7-day continuous period
Total Coliform Bacteria	23 MPN per 100 mL per sample, not to occur more than once within 30 days
Total Coliform Bacteria	240 MPN per 100 mL in any sample
Disinfection Contact Time (CT)	Greater than or equal to 450 mg-min/L with a minimum modal contact time of at least 90 minutes under peak dry weather conditions

Disinfected secondary-2.2 recycled water is used for the surface irrigation of food crops where the edible portion is produced above ground and not in contact with the recycled water. Disinfected secondary-2.2 recycled water refers to recycled water that has been oxidized and disinfected so that the median concentration of total Coliform bacteria in the disinfected effluent does not exceed a MPN of 2.2 per 100 milliliters (mL) utilizing the bacteriological results of the last 7 days for which analyses have been completed. In addition, the result of total Coliform bacteria does not exceed an MPN of 23 per 100 mL in more than one sample in any 30 day period.

Recycled water used for the surface irrigation of any non-edible vegetation where public access is controlled so that the irrigated area is not part of a park, playground or school yard must be at least disinfected secondary-23 recycled water. Disinfected secondary-23 recycled water refers to recycled water that has been oxidized and disinfected so that the median concentration of total Coliform bacteria in the disinfected effluent does not exceed a MPN of 23 per 100 mL utilizing the bacteriological results of the last 7 days for which analyses have been completed. In addition, the result of total Coliform bacteria does not exceed an MPN of 240 per 100 mL in more than one sample in any 30 day period.

6. Conclusions and Recommendations

For countries such as Mexico where the water supply is scarce and public wastewater treatment is insufficient, localized wastewater treatment is an effective solution for water conservation. The reuse of water in this manner provides additional water supply while reducing consumption from precious aquifer sources.

In Mexico, the main incentive for waterwater treatment and water reuse by industry and commercial facilities is driven by current fresh water allocation based on the facility's surface area. The locally installed WWTSs appear to be highly flexible in design and efficient in treating the combined sanitary and food processing wastewater. The WWTSs observed at the Wal-Mart sites are capable of generating approximately 5,000-10,000 gallons per day (gpd) of reusable water for on-site toilet/urinal flushing and exterior irrigation.

The use of packaged wastewater treatment systems like the Wal-Mart WWTSs in the United States (U.S.) is not a viable option because of a well-established wastewater treatment infrastructure, strict government

health and water quality regulations and expensive labor. For instance, under the California recycled water regulations, depending on the area of application, recycled water must achieve a lower bacteria count than the Mexico recycled water quality standards. In addition, the recycled water used for toilet and urinal flushing is tertiary disinfected recycled water with higher quality.

Other issues that would be in non-compliance with the U.S. environmental regulations include direct and manual handling of sanitary sewage and disposal of raw sanitary waste to the trash collection system. If compared to the U.S. Occupational Health and Safety Administration (OSHA) requirements, well ventilated and safe working conditions are minimum requirements which must be maintained.

The visited WWTSs Trapzilla® units are not strictly used as oil and grease interceptors but are functioning instead as an equivalent of sedimentation basins in a conventional secondary treatment plant. Therefore, the oil and grease removal efficiency of the Trapzilla® units as grease interceptors could not be evaluated. As the units are cleaned regularly and TSS removal is not monitored, the Trapzilla® performance as a primary sedimentation unit could not be evaluated either. However, based on EEC's observations, the Trapzilla® units appeared to be able to remove constituents, including settleable solids, oil and grease to a satisfactory level and conditioning the wastewater for the downstream biological treatment processes.

EEC visited only the WWTSs designed by one local contractor, and therefore, a comparison between different treatment approaches was not possible. Based on EEC's observations, future areas of improvement may include energy optimization (with regards to air supply to the bioreactors), tracking system production efficiency (i.e., in terms of recycled water production and treated water unit costs), working environment improvements (such as sufficient ventilation) and improvements on O&M practices.

7. Summary

On-site packaged Waste Water Treatment Systems (WWTSs) discharging into a water reuse system (toilets, urinals and irrigation) as observed at four Wal-Mart locations in Mexico City appear to be providing a viable means for extending the water supply in this water limited region. These on-site packaged WWTSs help increasing the City's wastewater treatment capacity. The double benefit of providing wastewater treatment capacity and water reuse is viewed as the optimal choice for regions with limited potable water supplies and insufficient municipal wastewater treatment capacity.