NEW SOLUTION FOR PRIMARY WASTEWATER TREATMENT; CLOTH MEDIA FILTRATION

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Introduction

Primary and Primary Effluent Cloth Media Filtration are emerging technologies in wastewater treatment. The goal of these technologies is to reduce the organic loading to the secondary treatment process, which saves energy and can increase capacity. This is achieved by diverting Biological Oxygen Demand (BOD_5) and Volatile Suspended Solids (VSS) from raw wastewater prior to main biological treatment and the anaerobic digestion process, reducing activated sludge loading and increasing gas production in the digestion process. Figure 1 and Figure 2 show typical plant schematics for primary filtration and primary effluent filtration, respectively. In primary filtration, the cloth media filter replaces the primary clarifier. In primary effluent filtration, the cloth media filter follows the primary clarifier and before the secondary process.

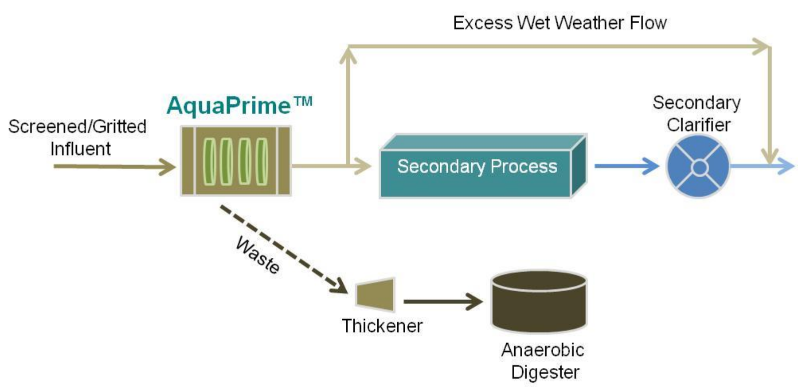

Figure 1: Plant Layout for Primary Filtration

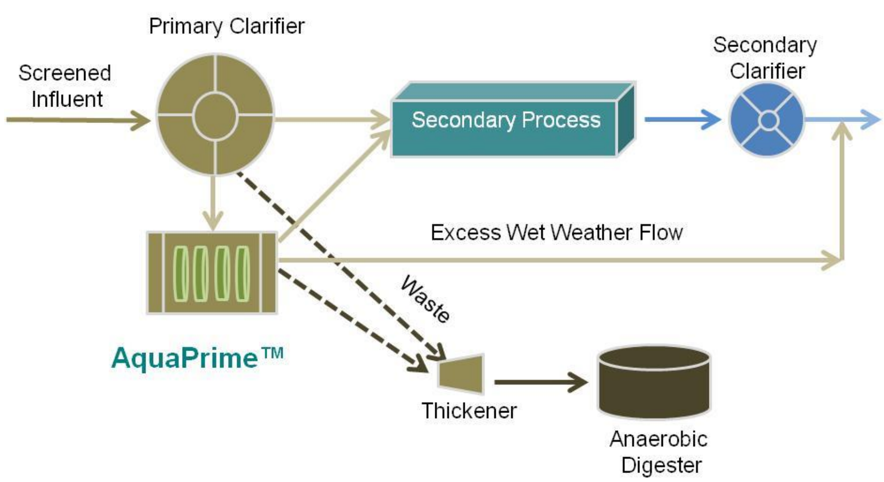

Figure 2: Plant Layout for Primary Effluent Filtration

An additional application may consist of filtration of Gravity Thickener Overflow (GTO) and centrate sidestreams as a pre-treatment step to remove solids and debris. This has the potential to decrease operation and maintenance costs by reducing the BOD_5andTSS/ VSS load. Capturing solids and diverting TSS/VSS and BOD_5 from the proposed sidestream biological treatment to the anaerobic digesters has the same potential to reduce aeration demand and operational costs.

Background

Aqua-Aerobic Systems became involved with primary effluent filtration in 2013 with a study funded by the California Energy Commission (CEC) and Kennedy Jenks Consultants. Five technologies were selected to participate in this study. The cloth media filter performance exceeded expectations. The unit ran the entire two years with 99% uptime and no cloth wear. TSS was reduced by 50-60% to the aeration basin. By the end of the study, the Aqua MiniDisk® cloth media filter was one of only two technologies remaining.

Below are TSS and Chemical Oxygen Demands (COD) removal rates during the year, plus phase 1 of the CEC study:

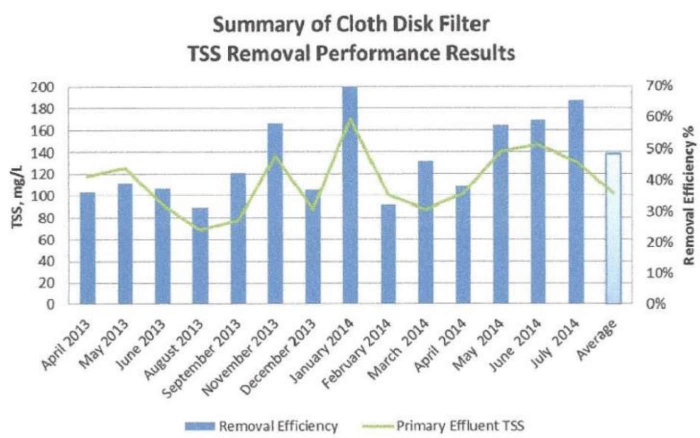

Figure 3: TSS Removal in CEC Study for the Cloth Disk Filter

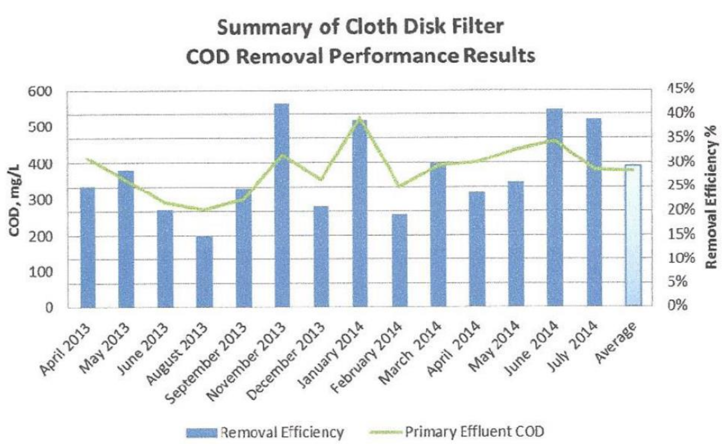

Figure 4: COD Removal in CEC Study for the Cloth Disk Filter

Based on the success from the California Energy Commission Study, Aqua-Aerobic Systems decided to conduct independent testing of primary filtration at the Rock River Water Reclamation District in Rockford, IL. This testing was conducted over six months using water pumped from before the primary clarifier. The process schematic is shown in Figure 3. The performance of the primary clarifier was compared to the performance of the cloth media filter. OptiFiber PA2-13® Cloth Filtration Media and OptiFiber PES-14® Cloth Filtration Media were tested during this study with success.

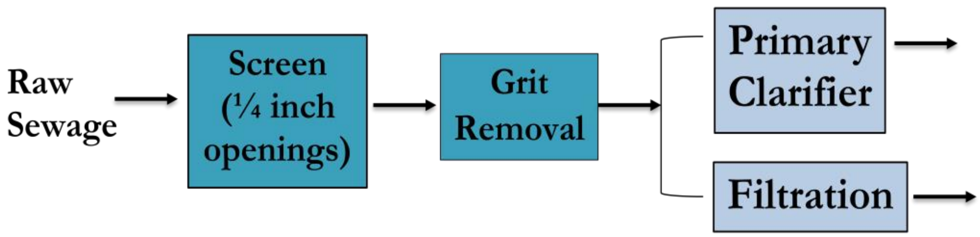

Figure 5: Rock River Water Reclamation District Primary Filtration Study Process Flow

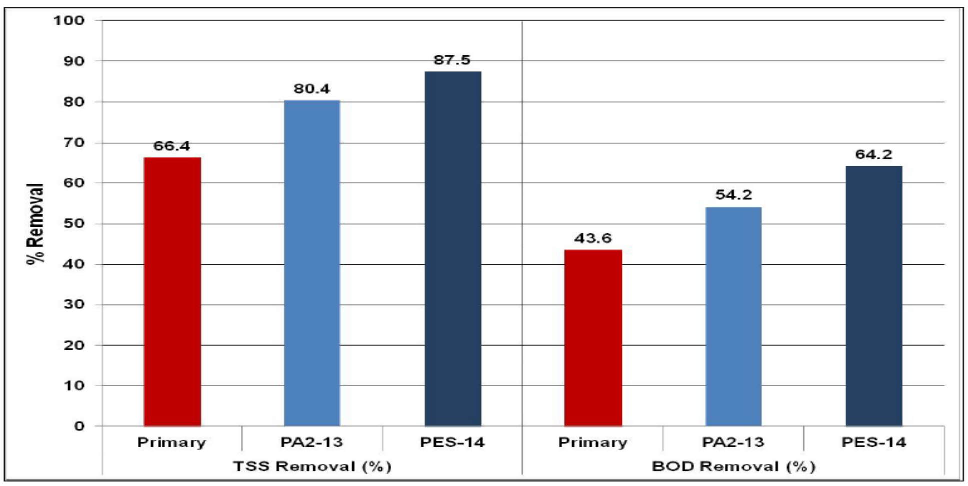

Figure 6: TSS and BOD Removal across Primary Clarifier, PA2-13 Cloth, and PES-14 Cloth in Rock River Water Reclamation District Study

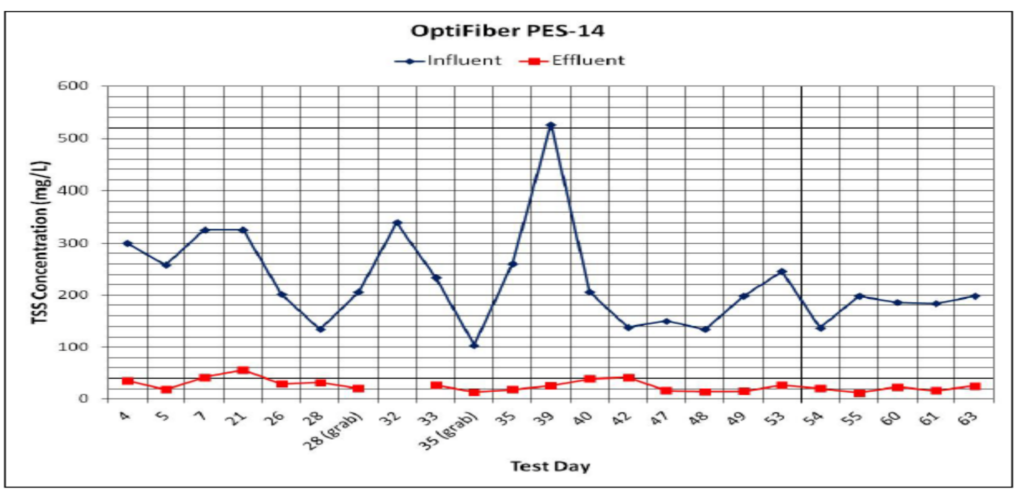

Figure 7: TSS Removal across Primary Clarifier PES-14 Cloth in Rock River Water Reclamation District Study

Based on successful testing, Aqua-Aerobic Systems developed several pilot units.

CMF Unit Design

Cloth media filtration has been used in tertiary applications for over 20 years. Its proven performance and operational advantages models a viable solution for primary filtration or wet weather treatment applications.

The outside-in flow path in cloth media filters allows for three zones of solids removal. These three zones become even more critical in wet weather applications due to the high solids environment in primary filtration and wet weather treatment applications. These zones are shown in Figure 8.

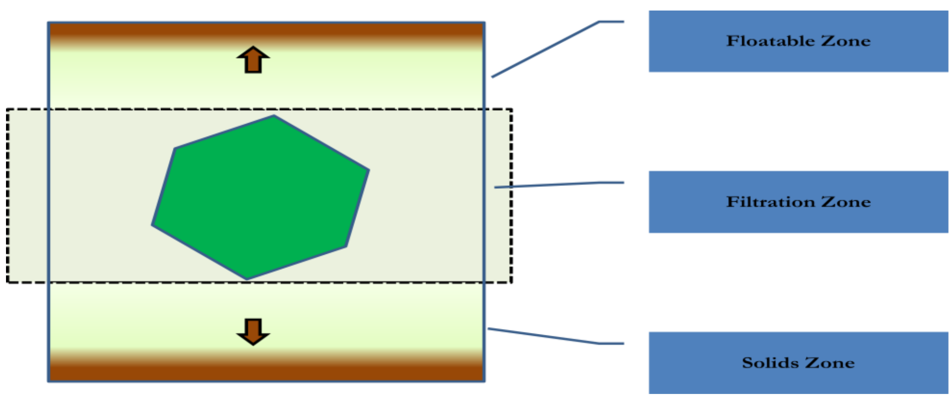

Figure 8: Three Zones for Solids Removal in a Cloth Media Filter

Floatable Zone

The top zone is the "floatable zone" where floatable scum is allowed to collect on the water surface. As the water level increases, the scum is removed by flowing over the scum removal weir. It is then directed to the plant's waste handling facilities. The floatable scum is removed typically 1 to 3 times per day by opening a floatable valve.

Filtration Zone

The middle zone is the "filtration zone" where the majority of solids are removed through filtration. Here, solids deposit on the outside of the cloth media forming a mat as filtrate flows through the media. Once a predetermined liquid level or time is met, the backwash shoe contacts the media directly and solids are removed by vacuum pressure using the backwash pump. During backwash, fibers fluidize to provide an efficient release of stored solids deep within the fiber (Figure 9).

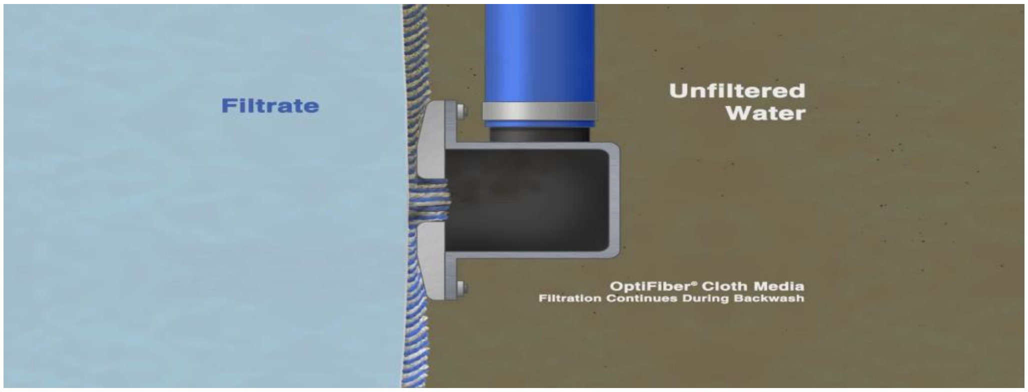

Figure 9: Backwashing of the cloth media.

Solids Zone

The bottom zone is the "solids zone" when heavier solids collected on the bottom of the tank are removed on an intermittent basis. The solids are removed from the hopper with collection laterals and the backwash pump.

CMF Arrangement

With knowledge of the three zones, Aqua-Aerobic Systems looked for ways to further improve solids removal. A floatable baffle and valve were added to remove floatable scum that accumulates in the floatable zone of the tank. The solids zone was enhanced by improving the hopper bottom design and adding an improved solids collection manifold. Other enhancements include elevating the tank height, moving the influent baffle, and raising the centertube.

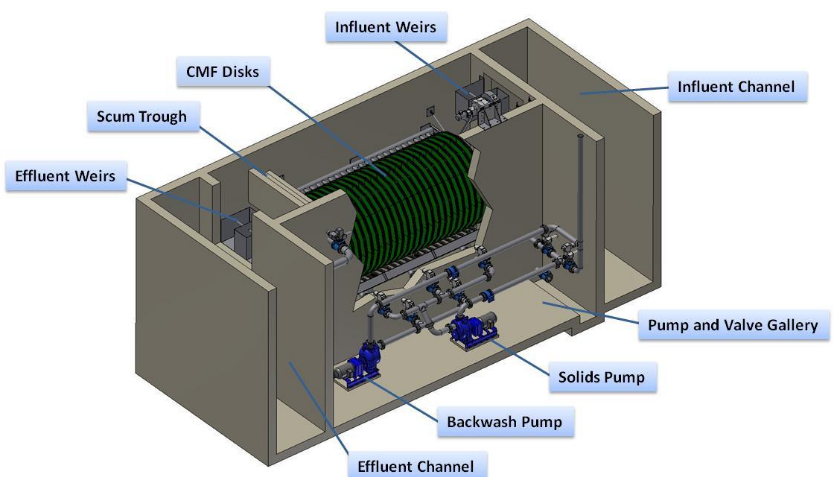

Figure 10: CMF Package Unit – 108 ft^2 Disks

Pilot Testing and Case Studies

Aqua-Aerobic Systems has constructed a pilot trailer and three stand alone units specifically designed for primary filtration and wet weather filtration applications. The unit is shown in Figure 11. The cloth media filter in this pilot unit features the modifications that are described above. The unit is currently traveling the country and collecting data at various plants.

Figure 11: Primary Filtration and Wet Weather Pilot System

Pilot Results

Aqua-Aerobic Systems has completed primary filtration studies at five (5) sites. The results from these studies are summarized in Table 1 and Table 2. The percent TSS removal is consistently between 80 and 88% in these studies. Variations in BOD removal are due to differences in the fraction of BOD that is soluble among these sites.

	Media	Influent (mg/L)	Effluent (mg/L)	Removal
RRWRD	PA2-13	253	44	80%
RRWRD	PES-14	221	26	88%
Oak Hill, WV	PES-14	176	31	81%
The Dalles, OR	PES-14	206	40	80%
Asheville, NC	PES-14	188	24	87%
TRA, TX	PES-14	273	33	87%
Prescott, AZ	PF-14	188	33	82%

Table 1: TSS Removal Using Primary Filtration

	Media	Influent (mg/L)	Effluent (mg/L)	Removal (%)
RRWRD	PA2-13	220	95	54%
RRWRD	PES-14	169	59	64%
Oak Hill, WV	PES-14	242	149	40%
The Dalles, OR	PES-14	168	65	59%
Asheville, NC	PES-14	184	112	40%
TRA, TX (COD)	PES-14	487	204	58%
Prescott, AZ	PF-14	225	112	50%

Table 2: BOD Removal Using Primary Filtration

Primary Filtration Pilot Results

Below are some primary influent results from some of the studies:

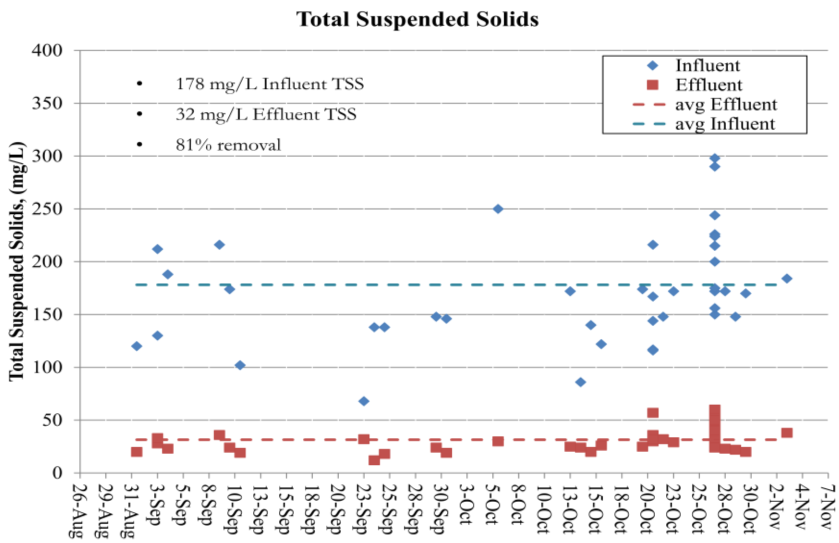

Figure 12: Oak Hill, WV – Primary Filtration - TSS

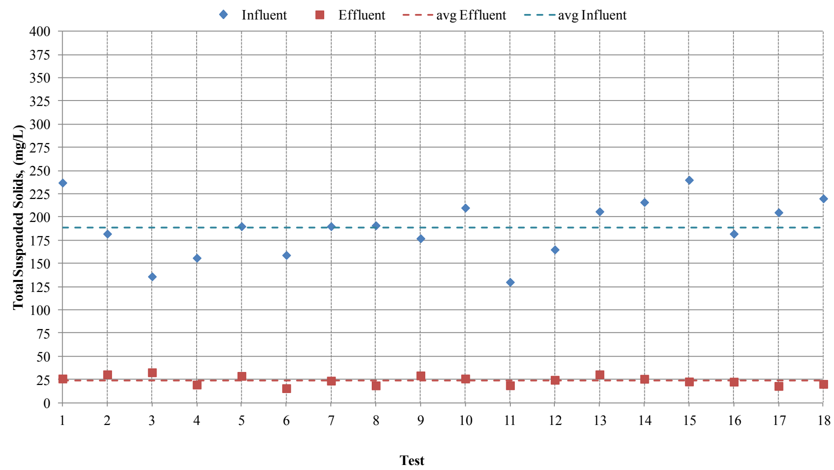

Figure 13: Asheville, NC – Primary Filtration - TSS

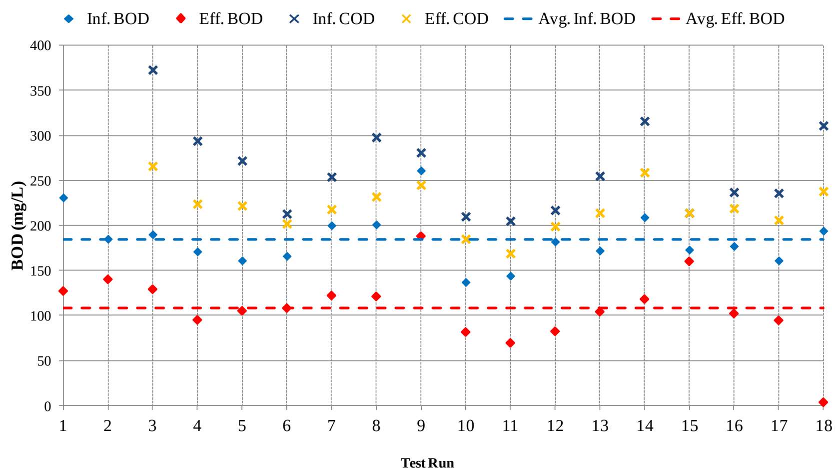

Figure 14: Asheville, NC – Primary Filtration - BOD

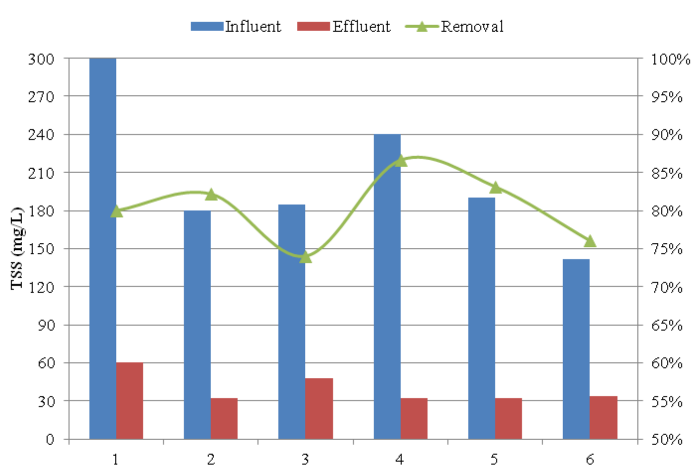

Figure 15: Dalles, OR – Primary Filtration – TSS

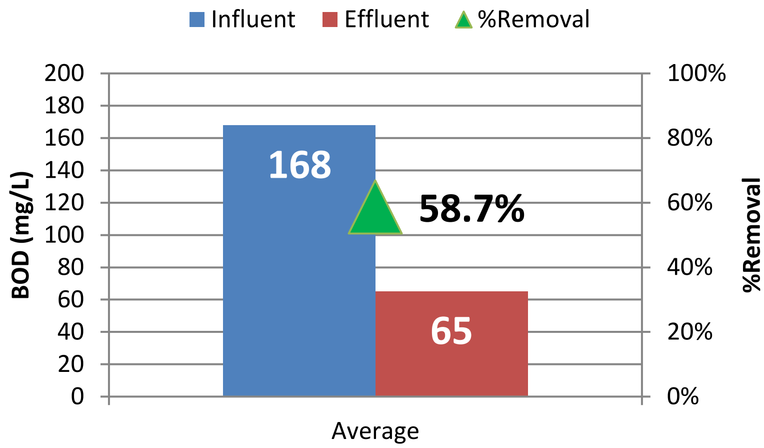

Figure 16: Dalles, OR – Primary Filtration – BOD Reduction

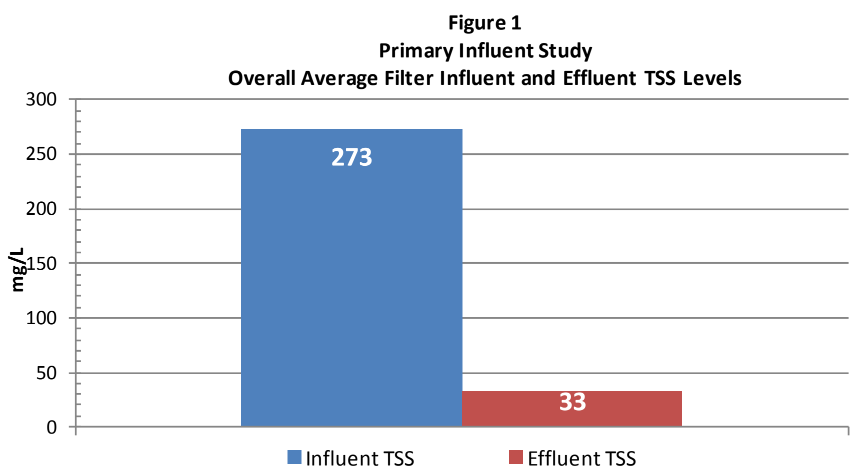

Figure 16: TRA Central, TX – Primary Filtration

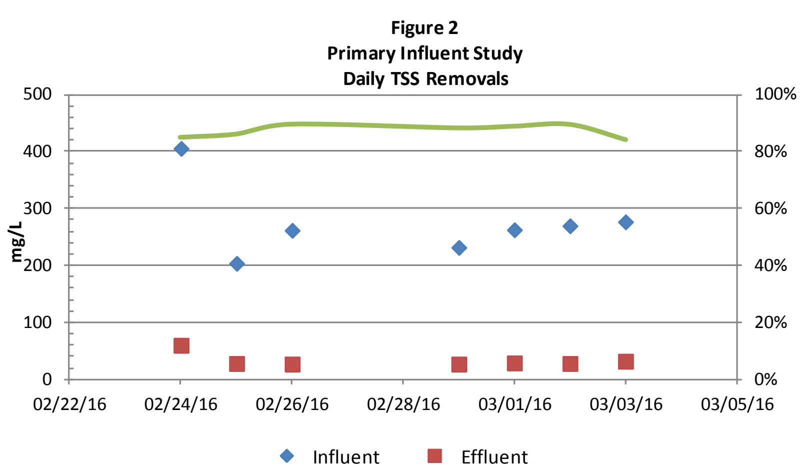

Figure 17: TRA Central, TX – Primary Filtration – TSS Removal

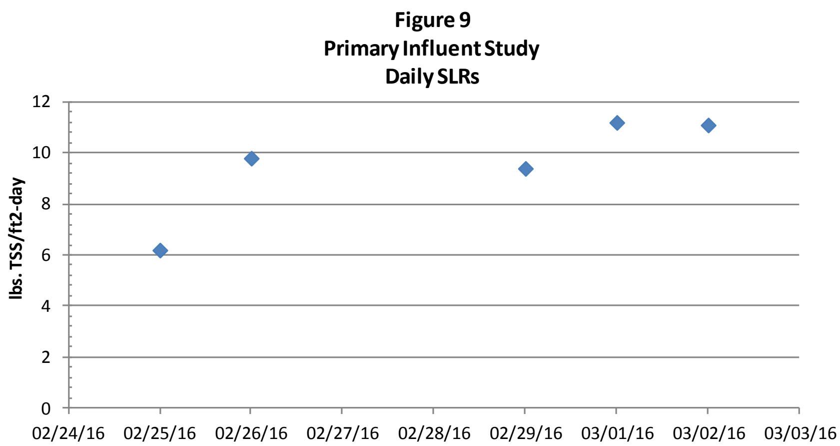

Figure 18: TRA Central, TX – Primary Filtration – Solids Loading Rate

Primary Effluent Filtration Pilot Results

Below are some primary influent results from some of the studies:

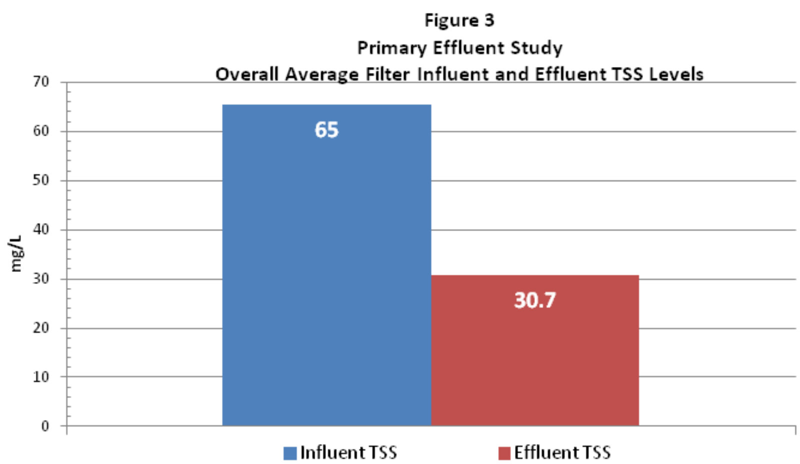

Figure 19: TRA Central, TX – Primary Effluent Filtration – TSS

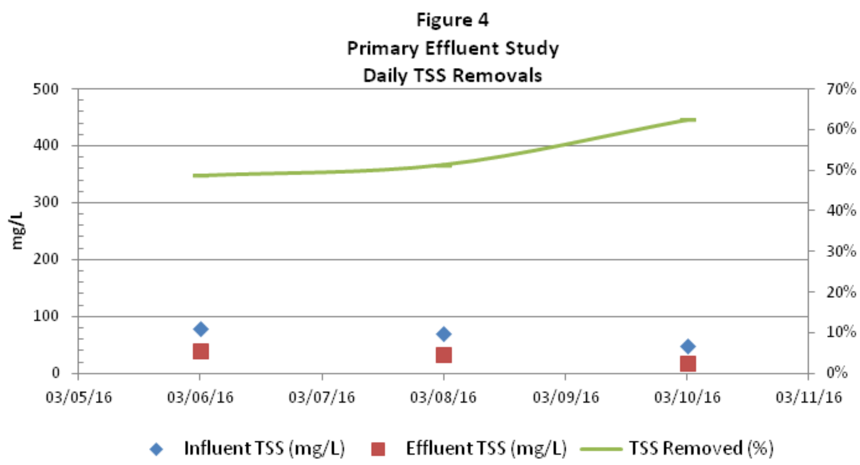

Figure 20: TRA Central, TX – Primary Effluent Filtration – TSS

Full Scale Testing

Following the success of the first California Energy Commission study, a second study has been approved to assess the full-scale impact of primary filtration over a three year period in Linda County, CA. The current plant has two trains designed for 1 MGD each. During the study, the primary clarifier in one of the two trains will be replaced with an AquaDisk® cloth media filter. These two trains will be operated independently and carefully monitored for differences in performance and microorganism populations. The biological process has a Modified Ludzak-Ettinger (MLE) configuration for nitrogen removal, which will help to answer how primary filtration impacts nutrient removal. This study is set to start up in spring 2016.

Conclusions

The cloth media filtration technology is viable technology for treating many different primary and primary effluent applications. The CMF technology provides a high quality effluent, easy operation and major operating saving in reduced energy consumption in the treatment facility.

References

Caliskaner, Onder, Tchobanoglous, George, Young, Ryan and Laybourne, Sarah (2014) *Demonstration of Primary Effluent Filtration for Carbon Diversion to Save Energy and Increase Plant Capacity*, Proceeding WEFTEC 2014, New Orleans, LA