AQUA-AEROBIC SYSTEMS, INC.
A Metawater Company

AquaPrime™ Cloth Media Filter
PILOT CASE STUDY

Project Name and Location
Metropolitan Sewer District of Greater Cincinnati (MSDGC), Muddy Creek Remote CSO Site

Aqua -Aerobic Solution
AquaPrime™ Cloth Media Filter – CSO Filtration

Introduction

The Metropolitan Sewer District of Greater Cincinnati, OH (MSDGC) is responsible for treating all the wastewater and wet weather flows within the greater Cincinnati area. The MSDGC sewer network is comprised of sanitary sewer, combined sewer overflows (CSO), sanitary sewer overflows (SSO) and stormwater flows. CSOs are used to prevent street flooding, sewage backups and relieve the pressure in the sewer lines. The CSOs allow excess flows to exit the sewer system for discharge into streams, lakes and rivers through outfall structures. The water quality discharged to these receiving bodies during CSO events is shown in Table 1. When these CSO systems were built, they were an acceptable way of handling excess flows, but due to the environmental impacts on the receiving streams, are now controlled under the Clean Water Act.

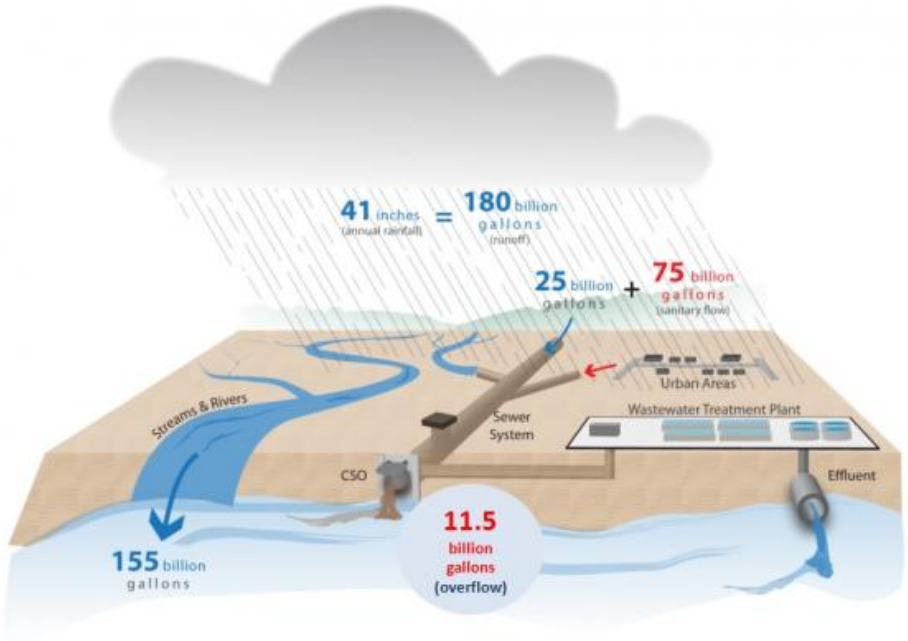

Figure 1: CSO Flow Balance (Courtesy of MSDGC Website)

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Table 1: MSDGC Typical CSO Water Quality Characteristics (Courtesy of MSDGC Website)

Value	TSS (mg/L)	$CBOD_5$ (mg/L)	E. Coli (ct/100 mL)
Min	60	10	10^5
Avg	154.6	39.2	10^6
Max	470	91	10^7

Forty percent of the flow in MSDGCs network is make-up of CSO flows. In accordance with the US EPA, CSO Control Policy, MSDGC has developed a Long Term Control Plan to address all the wet weather flows. The plan includes flow control, storage, treatment and separation of stormwater flows from the sanitary sewer network. The long term MSDGC treatment plan includes the construction of up to 11 High Rate Treatment facilities throughout the MSDGC network.

MSDGS's Watershed Operations (WO) Division is responsible for the operation and maintenance of these CSO treatment facilities which includes mostly screening and disinfection. This division manages a technical program to identify and evaluate emerging, innovative technologies to handle wet weather flows including CSOs. The program goals are to validate selected innovative technologies and determine treatment capabilities and life-cycle costs for possible implementation in their network. As part of the innovative technology program, MSDGC contracted with Hazen and Sawyer to conduct a pilot study with Aqua-Aerobic Systems, Inc. (AASI) to assess the potential use of the AquaPrime™ Cloth Media Filter for CSO treatment.

AquaPrime™ Process

The AquaPrime™ filter features an outside-in flow path which allows for three zones of solids removal that are shown in Figure 2. These zones are especially critical in wet weather applications due to the high solids typically associated with the first flush after wet weather events. The top zone is the "floatable zone" where surface materials such as fats, oils and grease are allowed to collect on the water surface. Solids are removed from this zone by allowing floating material to overflow a scum weir several times each day.

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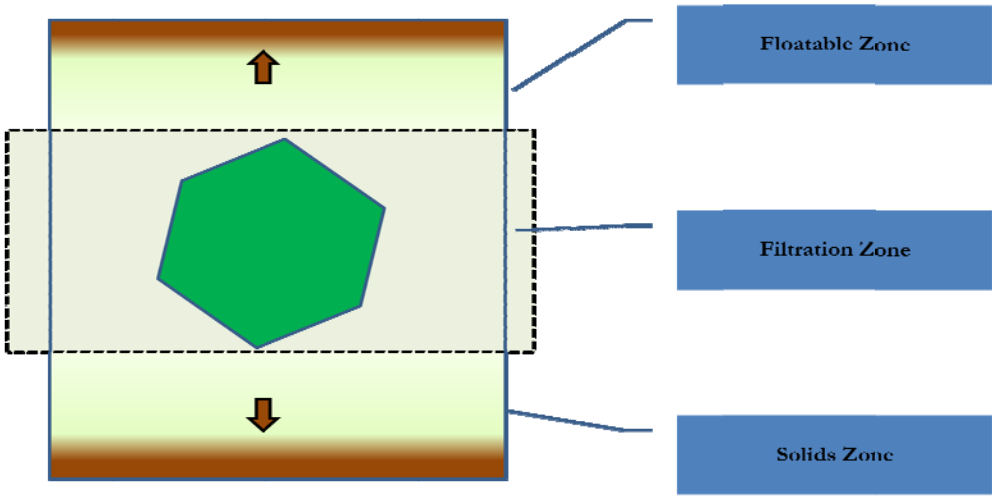

Figure 2: AquaPrime™ Process Diagram.

The middle zone is the "filtration zone" where solids are removed through filtration. Here, solids deposit on the outside of the cloth media forming a mat as filtrate flows through the media. This buildup of solids on the media creates hydraulic resistance to flow through the media and causes the water level in the tank to rise. Once a predetermined liquid level or time setting is attained, the disks begin to rotate and the backwash pump starts, which draws filtered water from the inside of the disk through the media and removes solids from the filter media's surface. This process fluidizes fibers to provide an efficient release of stored solids deep within the fiber. An illustration of the backwash mechanism is shown as Figure 3.

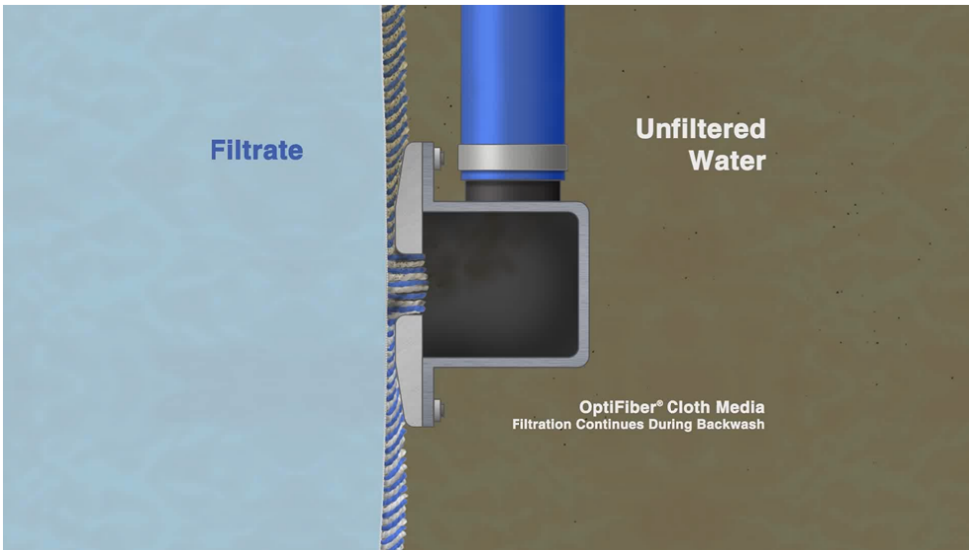

Figure 3: AquaPrime™ Backwash Illustration

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The bottom or “solids zone” permits heavier solids to settle to the bottom of the tank for intermittent removal. The solids are evacuated from the hopper through collection laterals using the backwash pump.

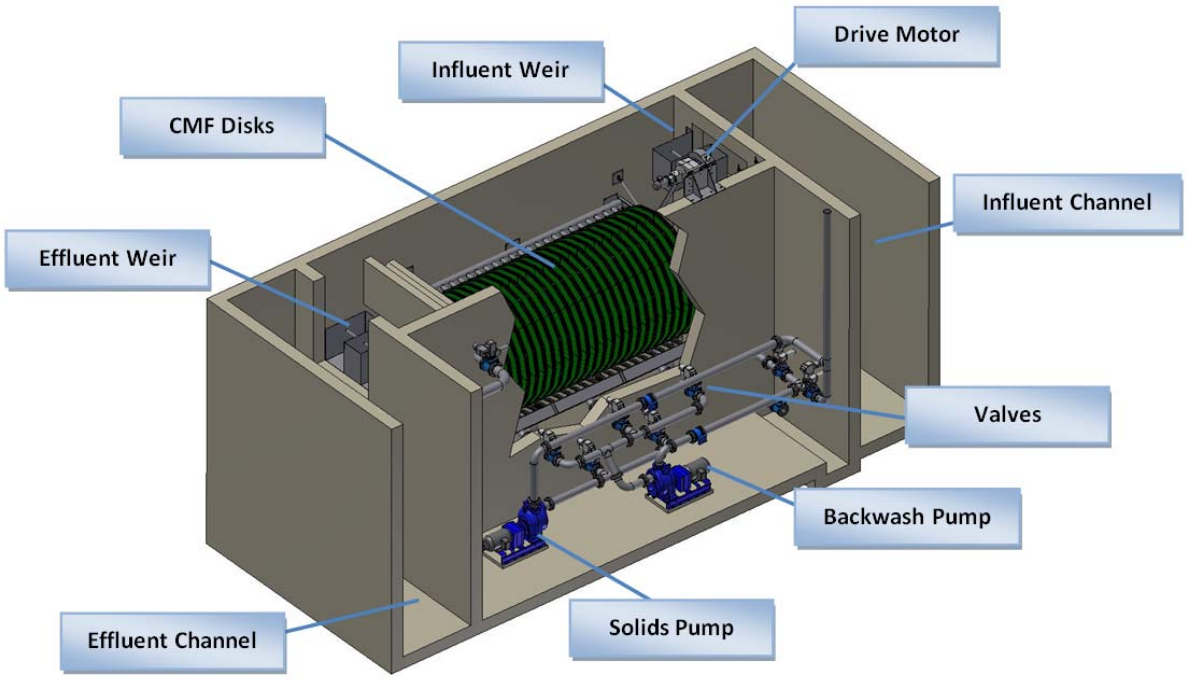

Figure 4: AquaPrime™ Arrangement.

Methods

An AquaPrime ™Cloth Media Filter was piloted for 3.5 months at the MSDGC Muddy Creek Remote CSO site. The pilot’s feed pump and float system was installed directly into the CSO channel. During wet weather events, the channel’s rising water level initiates the feed pump, prompting automatic operation of the filter. When the flows subsided, the float switch stopped the feed pump and placed the filter in an idle mode. Influent and effluent automatic composite samplers were used to draw samples at intervals in conjunction with grab samples. During the study, analysis was primarily conducted for TSS and BOD, but other parameters were analyzed such as particle and UVT. The sampling consisted of both composite and grab samples.

The AquaPrime MD-9 pilot unit shown below was used for the pilot study.

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Figure 4: AquaPrime™ Pilot Unit.

Results

Four major events were captured with the AquaPrime™ pilot unit. Table 2 presents the summary of the influent flow conditions and waste volumes during each event. A nominal hydraulic loading rate of 6.5 gpm/ft^2 was used for the first three events to match the standard design hydraulic loading rate for AquaPrime™ filters. A hydraulic loading rate of 7.0 gpm/ft^2 was used in the fourth event to push the filter beyond typical design values. The total waste flow was made up of backwash, solids waste, and scum waste. Scum waste represented a negligible fraction of the total waste volume. The total was volume was less than 5% of the forward flow through the filter in all cases. At a remote CSO site, it is assumed the waste flow with the solids removed would be returned to the sewer for treatment at the downstream treatment facility.

Table 2: Hydraulic Loading Rates and Waste Volumes for Four CSO Events

Event Start Date	Avg HLR (gpm/sf)	Backwash (%)	Solids Waste (%)	Total Waste Volume (%)
9/26/2016	6.5	3.3%	1.1%	4.3%
9/28/2016	6.5	2.9%	1.2%	4.1%
10/19/2016	6.5	2.1%	0.9%	3.0%
12/6/2016	7.0	2.7%	1.3%	4.0%

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Figure 5 demonstrate the TSS removal results from the four major events. The influent TSS varies significantly throughout a CSO event and is typically high at the beginning of an event and dramatically decreases after the first flush. Indexing auto-samplers were used to take samples at 15 minute intervals throughout each event. Filter effluent TSS ranged from 5 mg/L to 59 mg/L. The filter removed between 50% and 93% of the influent TSS. The TSS removal percentage increased as the influent TSS increased. All of the pilot work was done without the addition of coagulant, which would likely improve TSS reduction.

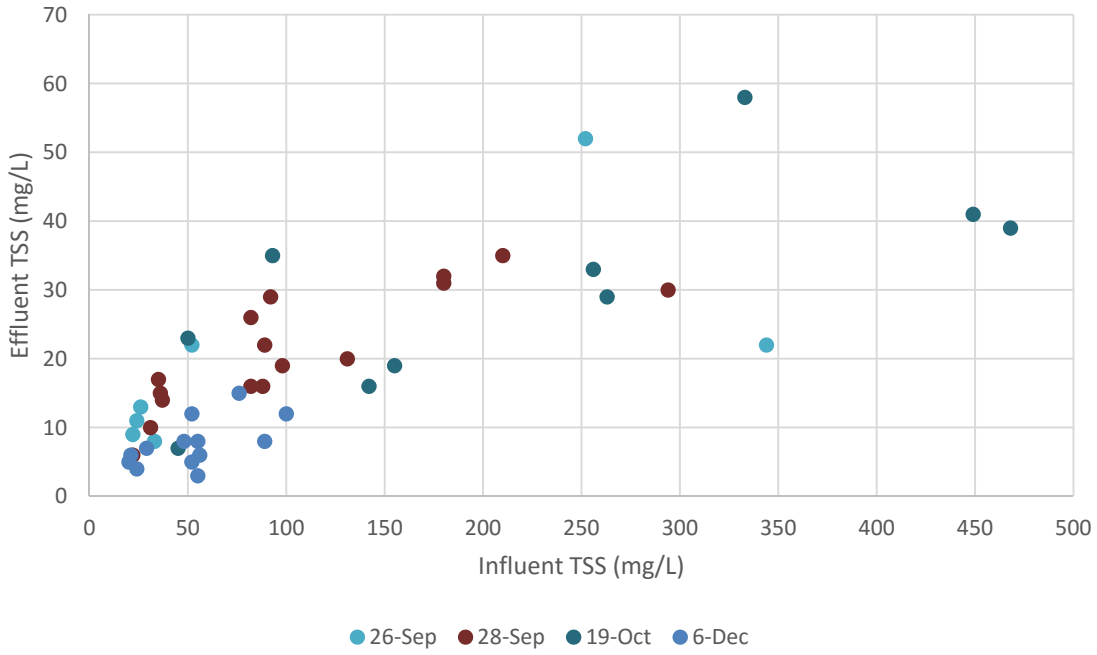

Figure 5: Effluent TSS vs. Influent TSS.

Figure 6 demonstrates the typical BOD removal seen during major events. During the study the cBOD removal can be as high as 70%. BOD removal varies greatly due to wide range of influent conditions. Cloth media filtration will only remove particulate BOD and at the end of the events there is very little BOD remaining in the influent and is mostly soluble.

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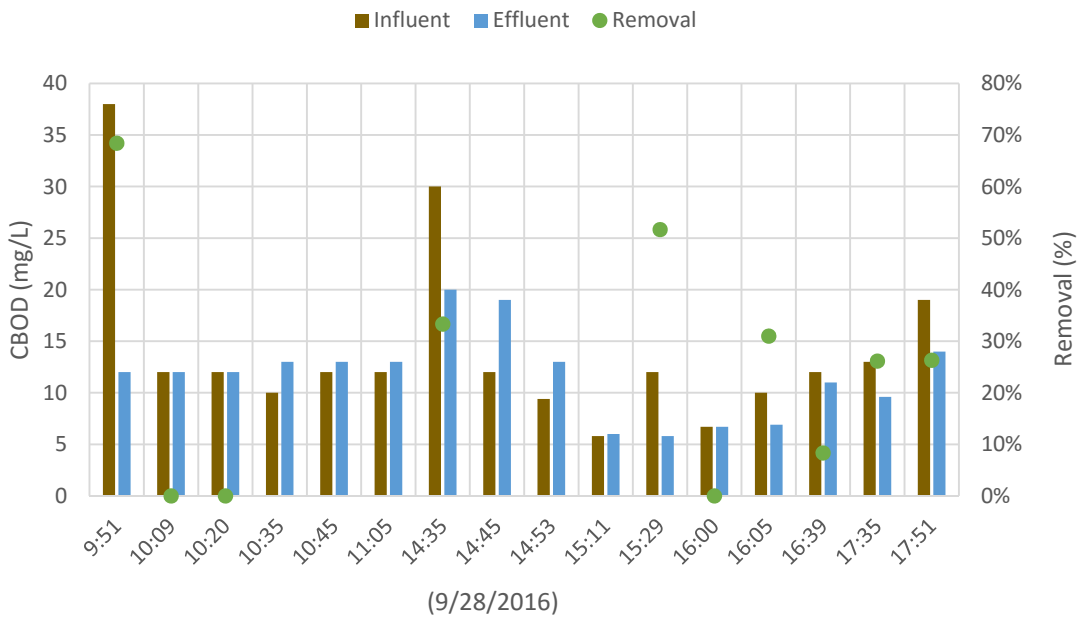

Figure 6: BOD Removal from Sept 28th event.

Figure 7 demonstrates the improvement in UVT with filtration.

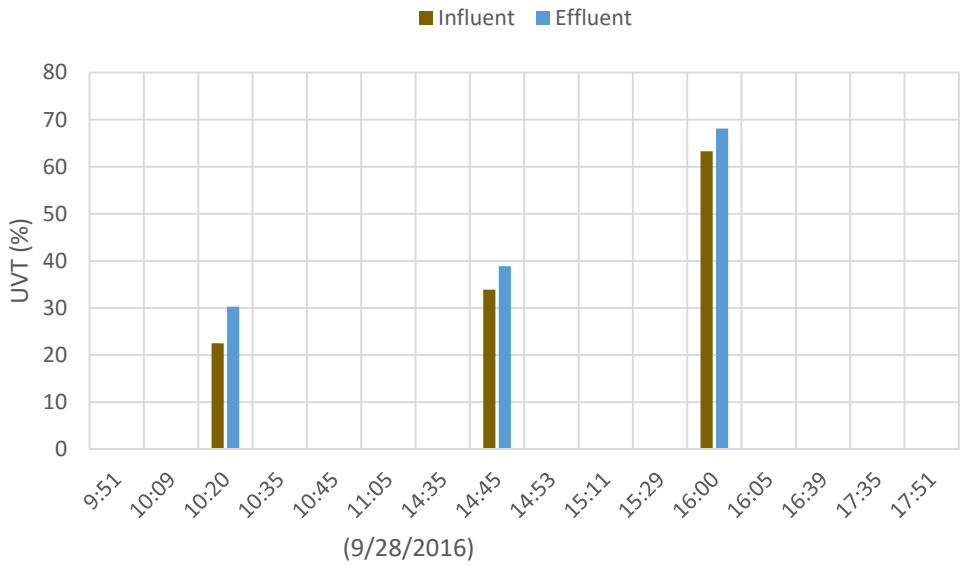

Figure 7: UVT improvement.

AquaPrime Cloth Media Filter Advantages for CSO Treatment

- Utilizes engineered OptiFiber® cloth filtration media
- Produces extremely consistent, high quality effluent
- Designed to handle extreme variation in TSS loadings
- Instant startup and instant high quality effluent
- Eliminates the need for chemical addition
- Low waste volumes
- Simple to operate and maintain
- Unmanned operation at remote sites
- Vertical oriented disks reduce the footprint; resulting in small overall site requirement

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