# Pilot Testing and Evaluation of Three Filtration Technologies for the Eugene / Springfield Wastewater Treatment Plant

2009 PNCWA Annual Conference

Boise, ID

September 15, 2009


By:

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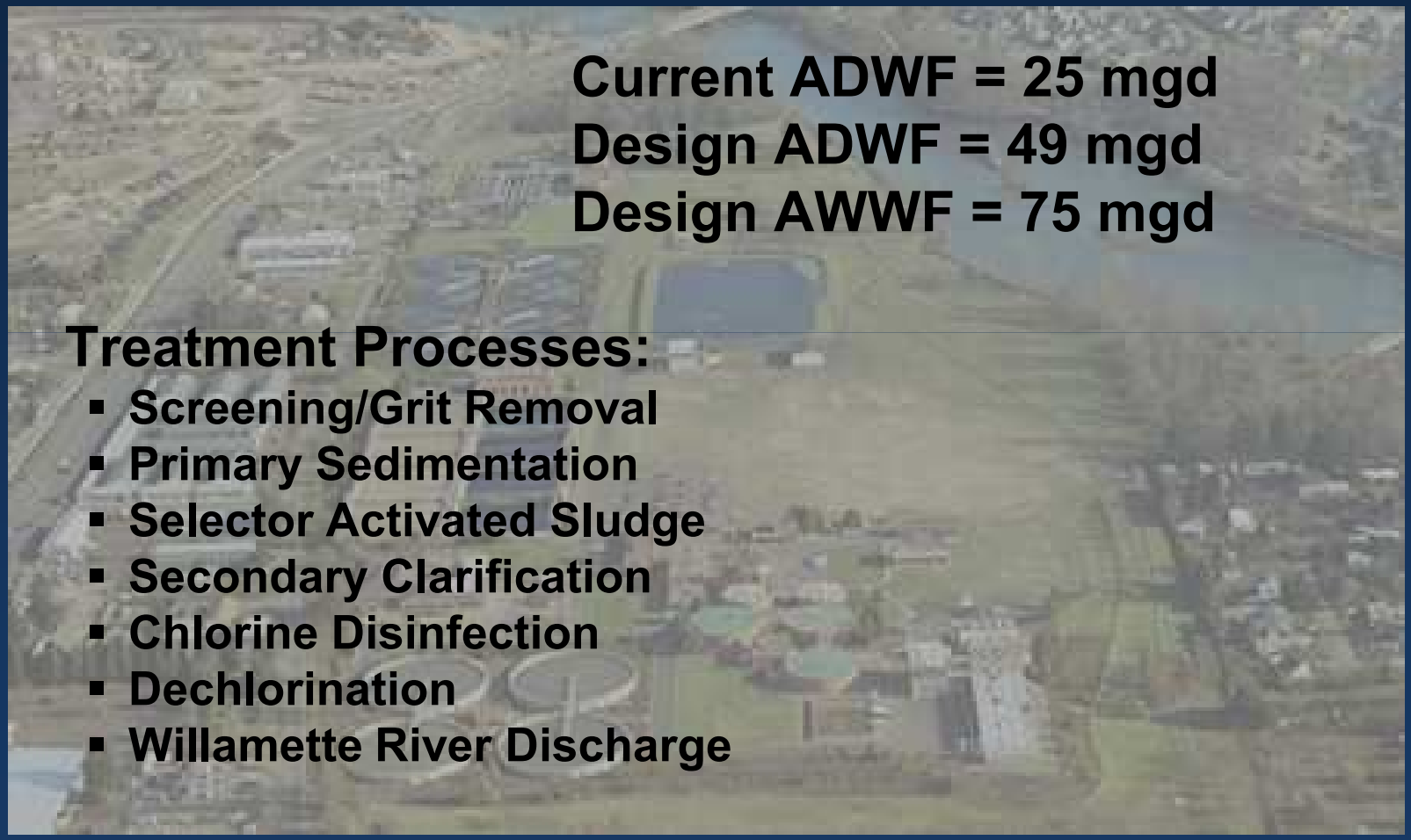
# Presentation Overview

- Project Overview
- Operational Perspective
- Pilot testing systems
- Pilot testing results
- Questions

# About MWMC

- Formed as a partnership between Eugene, Springfield, and Lane County. Established in 1978 to serve as recipient for EPA funding of new treatment facilities.
- City of Eugene operates and maintains treatment plant, biosolids facility and lift stations.
- City of Springfield provides administrative support of the regional wastewater program including management of the Capital Improvements Program.

# Eugene/Springfield WPCF



**Current ADWF = 25 mgd**
**Design ADWF = 49 mgd**
**Design AWWF = 75 mgd**

**Treatment Processes:**

- Screening/Grit Removal
- Primary Sedimentation
- Selector Activated Sludge
- Secondary Clarification
- Chlorine Disinfection
- Dechlorination
- Willamette River Discharge

# MWMC Facilities Plan

Cost-effective solution for regional for wastewater needs through 2025.

Established in a joint effort between MWMC and CH2M Hill.

Adopted in 2004

Tertiary filtration one of ten major capital improvement projects.

# Tertiary Filter Project

From *MWMC Facilities Plan*:

- Phase 1: 11 mgd filtration capacity
- Year 2025: 33 mgd filtration capacity
- Comply with effluent TSS limits
- Produce Class A recycled water
- Placeholder for future design

# Project Team

## Operation and Maintenance, City of Eugene

- **Bill Bennett, Filtration Pilot System O&M Lead**
- Steve Barnhardt
- Rick Clark
- Kim Olsen
- Dennis Gabrielson
- Matt Hays
- Chris Jeffress
- Tim Bridgeford

## Engineering

- **Yan Seiner, City of Springfield, MWMC Project Manager**
- **Onder Caliskaner, Kennedy Jenks, Tertiary Filtration / Pilot Testing Process Lead**
- Kevin Farthing, Kennedy Jenks, Pilot Testing Staff Engineer
- Steve Celeste, Kennedy Jenks, Tertiary Filtration Project Manager

# Project overview
# Approach

**Step 1.** **Filtration technology alternatives evaluation/selection**

*Outcome: Select three technologies for pilot testing*

**Step 2.** **Manufacturer selection for pilot testing: request for information process**

*Outcome: Select one manufacturer for each selected technology*

**Step 3.** **Conduct pilot testing**

*Outcome: Evaluate technology alternatives*

**Step 4.** **Preliminary design**

*Outcome: Select technology upon which to base design*

**Step 5.** **Design**

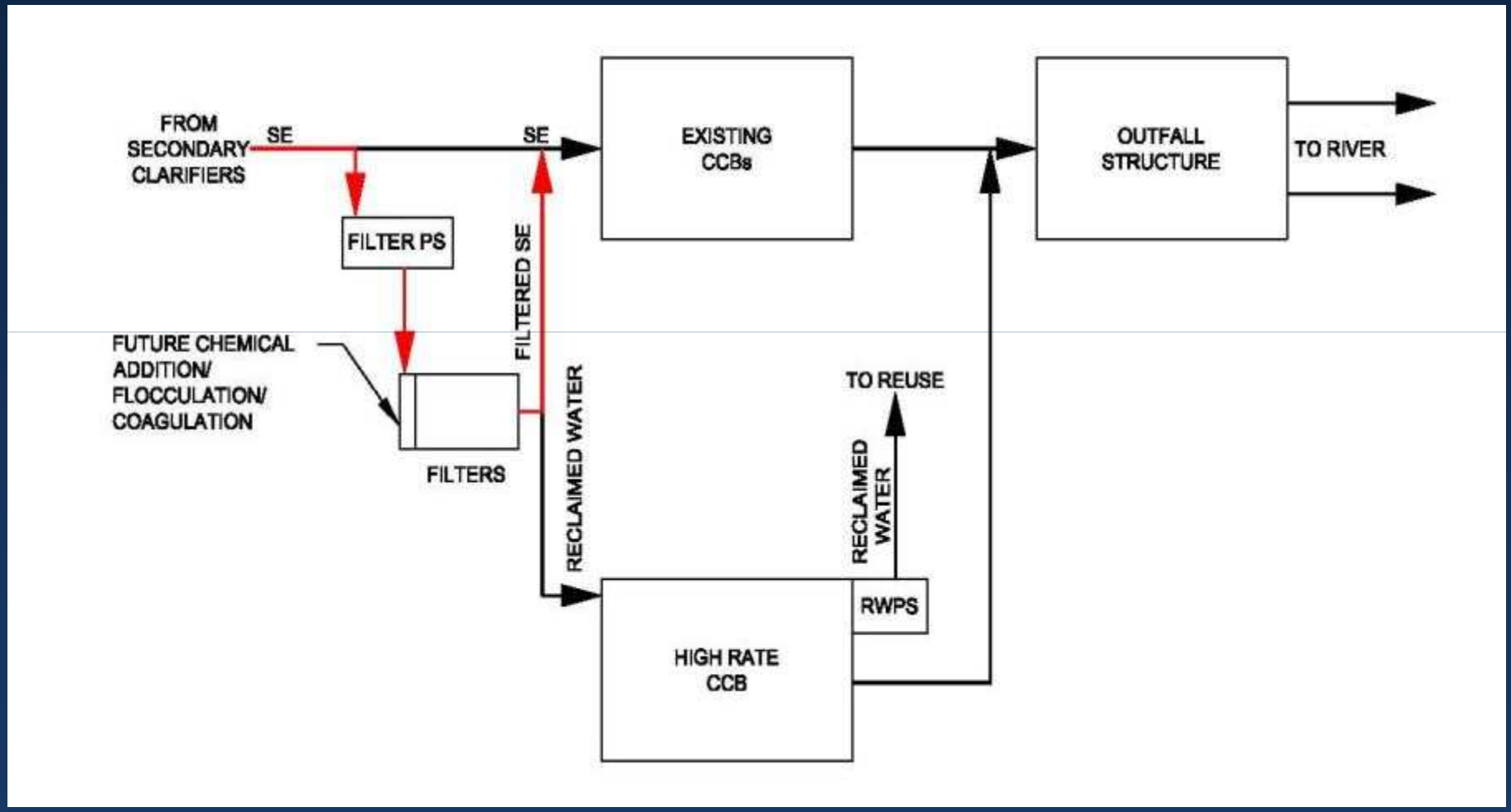
**Step 6.** **Bidding**

**Step 7.** **Construction**

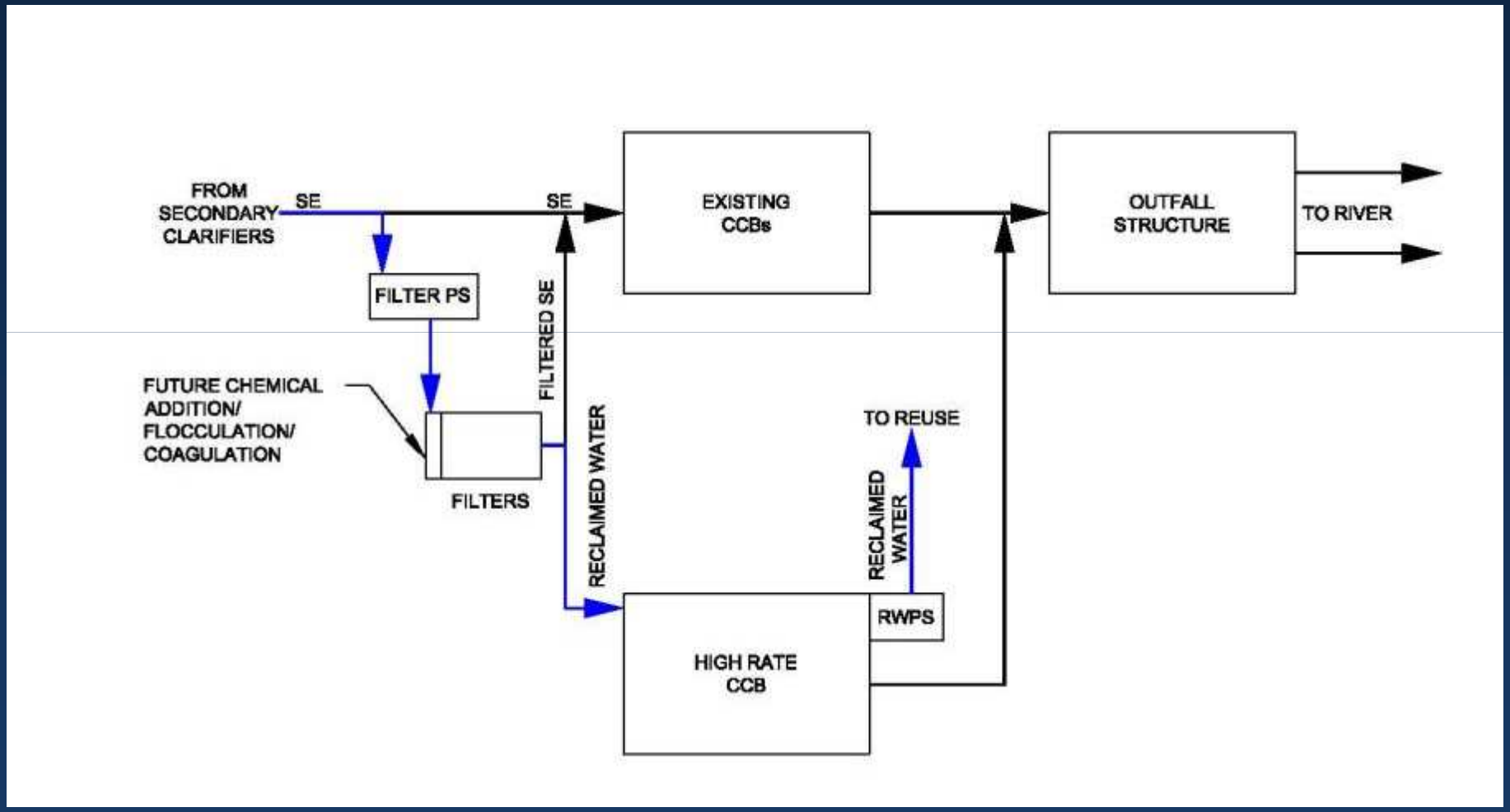
# Project objectives

- Comply with permit requirements
- Comply with Class A recycled water requirements
- Minimize energy demands
- Minimize chemical use
- Minimize impacts to other processes
- Flexible operations
- Maintainable
- Expandable
- Minimize footprint

# Project Overview
# Simplified flow diagram for Effluent TSS Removal



# Project Overview
# Simplified flow diagram for Class A Recycled Water



# Tertiary Pilot Filter Testing
# An Operational Perspective

## Eugene, Oregon

## July – November 2008

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# Pilot Filter Testing: Expectations

**Meet early on with consulting engineers:**

- **Determine types and number of filters to be tested.**
- **The number of test filters offered by vendors is limited and scheduling needs to be done well in advance of the project.**
- **Contracts will need to be negotiated with the vendors. Test filters are not free.**

**Have a goal of what information you want to get from the tests.**

- **Solids Removal.**
- **Ease of operation.**
- **Maintenance time, repair costs.**
- **Responsiveness of the vendors.**

# Pilot Test: Filter Site

Close to source of water to be treated.

Large enough to accommodate filters to be tested.

# Pilot Test: Water Source

**Process stream used for the pilot test should be the same as what will be used for the permanent installation.**

# Pilot Test: Power Supply

A power supply sufficient for all filters, pumps, and ancillary equipment will be needed.

Filter manufacturers will be able to supply data for their units.

# Pilot Test: Daily Checks

**FILTER #1: DAILY CHECK SHEET**

**Date:**_____ **Time:**_____

**Test Number**_____ **Op's Initials:**_____

| Local Panels | Turbidimeter | | | | | Particle Counter |
|---|---|---|---|---|---|---|
| Check for power and data displays | Clean lens | Clean lamp and glass under lamp | Drain and clean sample collection cell | If reading zero, check for burned out bulb. | Flush tubing as required | Clean strainers and tubing |
| | | | | | | |

| Sample Collection | | | | | |
|---|---|---|---|---|---|
| TSS | | | | Turbidity (Hand Meter) | |
| Influent Grab mg/l * | Influent Composite mg/l [1] | Effluent Grab mg/l | Effluent Composite mg/l[2] | Effluent NTU | Secondary Effluent Channel NTU |
| N/A | | | | | |

| Data Readouts | | | | | |
|---|---|---|---|---|---|
| Influent Flow gpm | Headloss (Goal <2" change) | Pump Pressure (Goal 40 psi) | Air Pressure (Goal 5 psi) | Effluent NTU | Effluent Particle Size |
| | | | | | |

| Sample Flow Rates (Timed measurement with graduated cylinder) | | Filter Flow |
|---|---|---|
| Effluent Turbiditmeter (Goal 400-600ml/min) | Effluent Particle Size (Goal 100 ml/min) | (If filter is not up to setpoint, shut unit down and clean inlet strainer.) |
| | | |

**Comments:**

Determine Frequency

Be Consistent with checks, corrections, and adjustments.

Coordinate sampling with equipment checks.

Document findings.

# Pilot Test: On Line Solids Meters

- **Turbidity Meters**
  - Require routine cleaning.
  - Flow rate adjustments need to be made based on vendor/consultant guide-lines.

- **Particle Counters**
  - Problematic with frequent plugging.
  - Flow rates were recommended, but difficult to maintain.

# Pilot Test: Sampling

## Composite Samples

- Allow for 24 hour sampling.
- 15-30 minute intervals recommended.
- Lab results can be compared to electronic data.


## Grab Samples

- Taken at time of equipment check.
- Results can be compared to on-line meters at time of sample.
- Designate specific sample points.

## All Samples can be stored and tested later.

# Pilot Test: Samples

- Sample Containers
  - One-liter bottles for grab samples.
  - Ten-liter bottles for composites.
  - Pre-labeled

- Green Transportation for delivery to lab.

# Pilot Test: Lab Tests

- **Turbidity Meter**
  - Additional data to augment online meters.
  - Use for composite and grab samples.
  - Hint: Pour sample into vials and allow to reach room temperature before running samples. Cold sample will fog the glass.

- **Suspended Solids**
  - Standard test as used for plant effluent.
  - Volume for lab tests may need to be adjusted when doing PE or upset testing.

# Pilot Test: Primary Effluent Testing

- **PE/Secondary Effluent**
  - PE diluted to ~50 mg/l to simulate high flow conditions.
  - Possible use of filters is to reduce effluent suspended solids to meet 85% removal and mass load requirements.

- **Dilution**
  - PE and SE mixed in injection chamber of off-line chlorine contact chamber.
  - 4” Chlorine line used to move PE from aeration basins to filters.
  - Suspended solids probe used to measure solids level and make dilution at the contact chamber.

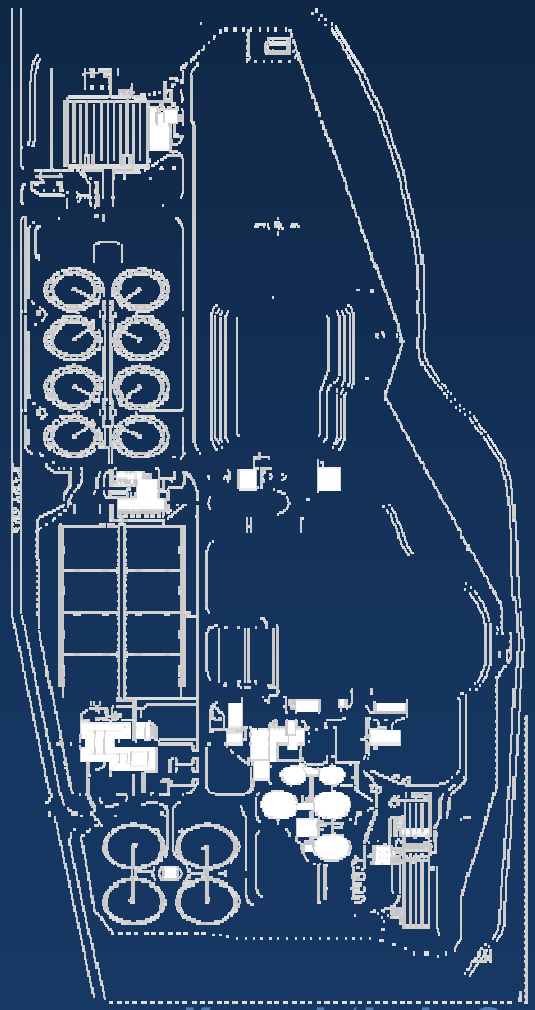
# Pilot Test: Plant Upset Testing

- **Mixed Liquor/Secondary Effluent**
  - ML diluted to ~25 mg/l to simulate upset of secondary treatment process.
  - Possible use of filters is to reduce effluent suspended solids during a plant upset to meet permit limits.

- **Dilution**
  - ML and SE mixed in injection chamber of off-line chlorine contact chamber.
  - 4” Chlorine line used to move ML from channel by secondary clarifiers to filters.
  - Suspended solids probe used to adjust flows to reach target.
  - Dilution not an exact science.

# Pilot Test: Experience Gained

- **Plan Ahead**
  - Samplers or other equipment may have a long delivery time.
- **Know Your Limitations**
  - Staffing requirements may be greater than anticipated.
    - A student or intern to check the filters and/or run lab samples would be an option.
- **Separate filters from ancillary equipment**
  - Problems with online meters or other equipment may not be indicative of filter performance.



# Pilot Study Results - Outline

- Objectives of pilot filter studies
- Pilot testing program and scope
- Pilot test program data / results
- Summary of performance results

# Pilot Filter Testing Program Objectives

**Principal objective:**

- Evaluate performance of filters with specific consideration of the recycled criteria and NPDES requirements

**Specific Objectives of the Pilot Testing Program:**

- Determine/Confirm design criteria
- Evaluation of the filters' reliability, operational and maintenance requirements
- Determination of the backwash requirements

# Pilot Filter Testing Program Scope

Testing of the following three filter technologies:

- Granular – Continuous Backwash Up-flow (Blue Water Technologies)
- Compressible Medium Filter (Schreiber)
- Disk Filter (Aqua Aerobics Systems)

at the following three filtration rates:

- Average filtration rate
- Design filtration rate
- Peak design filtration rate

for the following conditions:

- Secondary effluent filtration without chemical addition
- Secondary effluent filtration with chemical addition
- Primary effluent filtration and upset simulation testing

# Pilot Test Program

**Net testing : 20 weeks**

- Total of 31 tests for each pilot filter system
- Each test is between 2 and 7 days
- 25 tests for secondary effluent filtration without chemical addition : about 14 weeks
- Two tests for chemical addition : approximately three weeks
- One test for simulation of upstream upsets: approximately one week
- Three tests for primary effluent filtration: Approximately 10 days

# Pilot Filter Units

- Aqua Aerobic Systems cloth disk filter
- Schreiber compressible media filter
- Blue Water Technologies granular media filter

# Pilot Cloth Disk Filter

# Pilot Upflow Continuous Backwash Granular Filter

# Pilot Compressible Medium Filter



# Pilot Filters – Design Criteria

| | Filtration Surface Area, $ft^2$ | Hydraulic Loading Rate, $gpm/ft^2$ | | | Medium Properties | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Average | Design | Increased Design | Medium Depth, inches | Effective Size | Porosity % | Compres ratio % | Media Type |
| Continuous Backwash Granular Filter | 12 | 3.5 | 5 | 6-6.5 | 60 | 0.95 mm | 40 | N/A | Sand |
| Compressible Medium Filter | 2.25 | 20 | 30 | 35-40 | 30 | 0.17[(a)] | 85 | 5-40 | Synthetic |
| Cloth Disk Filter | 12 | 3.25 | 6 | 7 | 0.2 | 10 μM | | N/A | Pile Cloth |

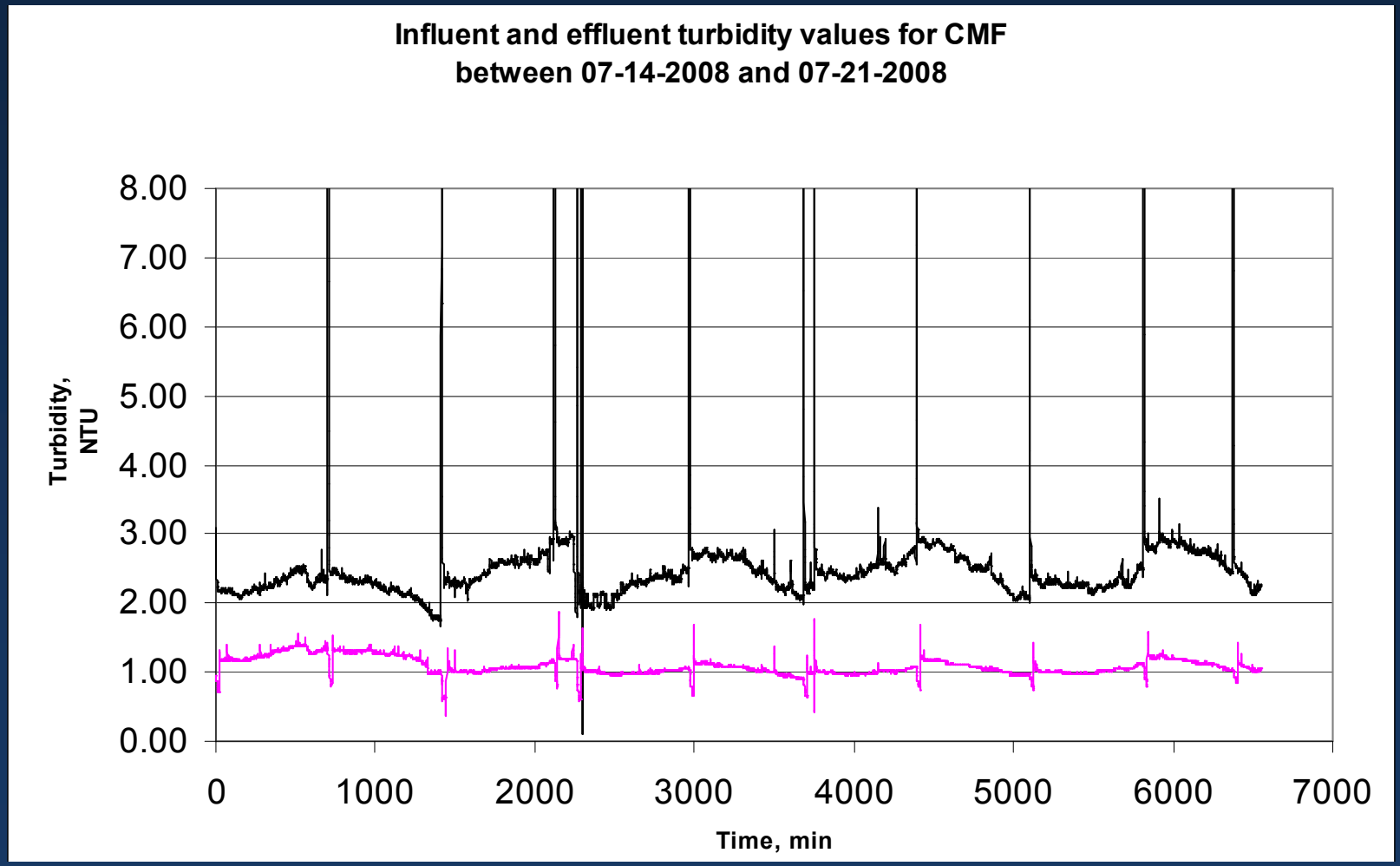
# Evaluation of Filtration Technologies Performance Criteria

- Turbidity / TSS removal
- Headloss development
- Backwash reject ratio
- Chemical aid requirements
- Particle size distribution modification

# Turbidity and TSS Requirements/Objectives

| | Parameter | Objective |
|---|---|---|
| Turbidity (NTU) | Daily Average | < 2 |
| | Not to exceed more than 5% of the time | 5 |
| | Cannot exceed at all times | 10 |
| TSS (mg/l) | Monthly Average | < ~ 4 - 5 |
| | Daily Maximum | < ~ 10 - 15 |

# MWMC Compressible Medium Filter Turbidity Removal Performance

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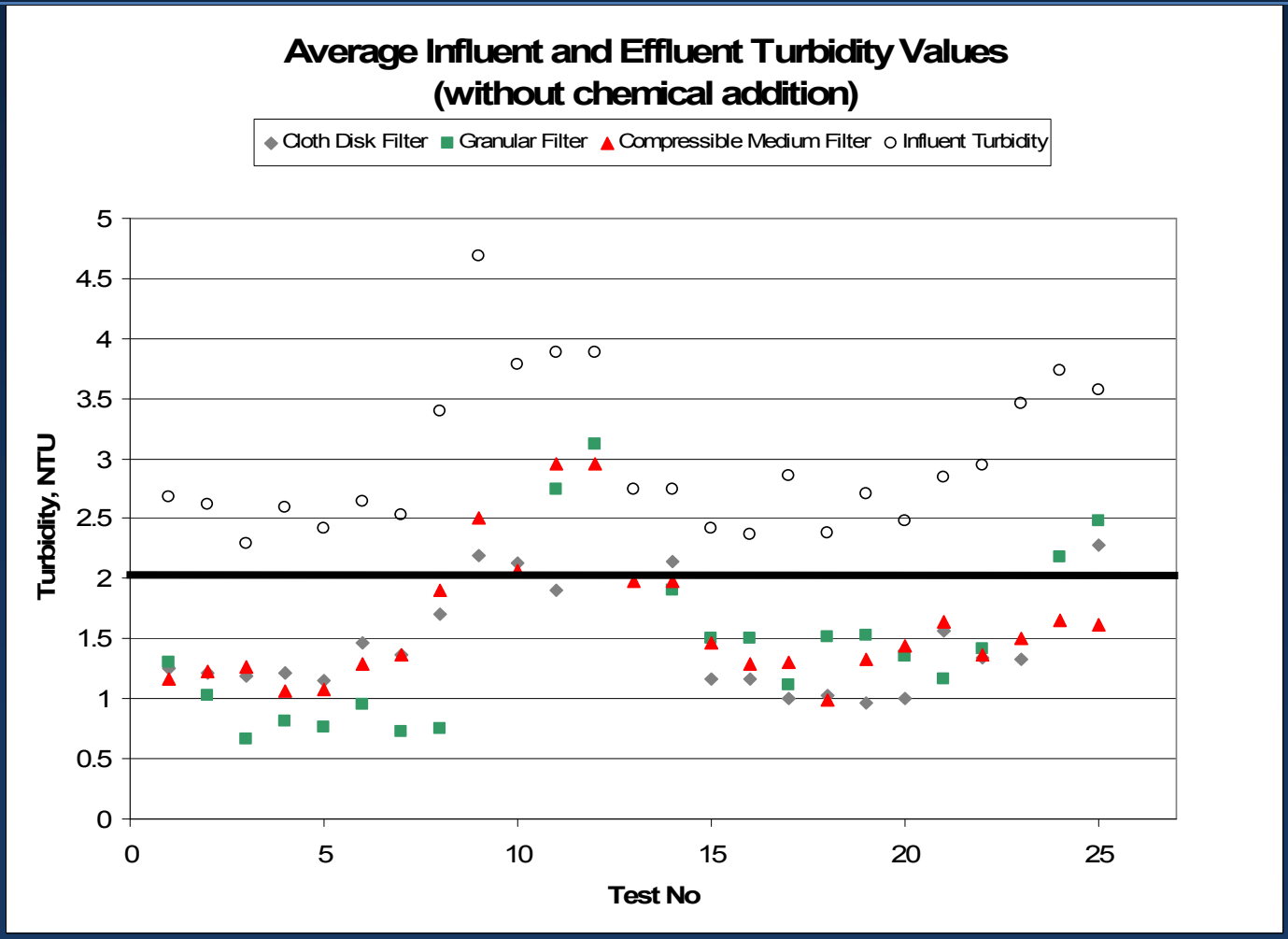
# Pilot Filter Testing Program
# Summary of Average Effluent Turbidity Results

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# Pilot Filter Testing Program
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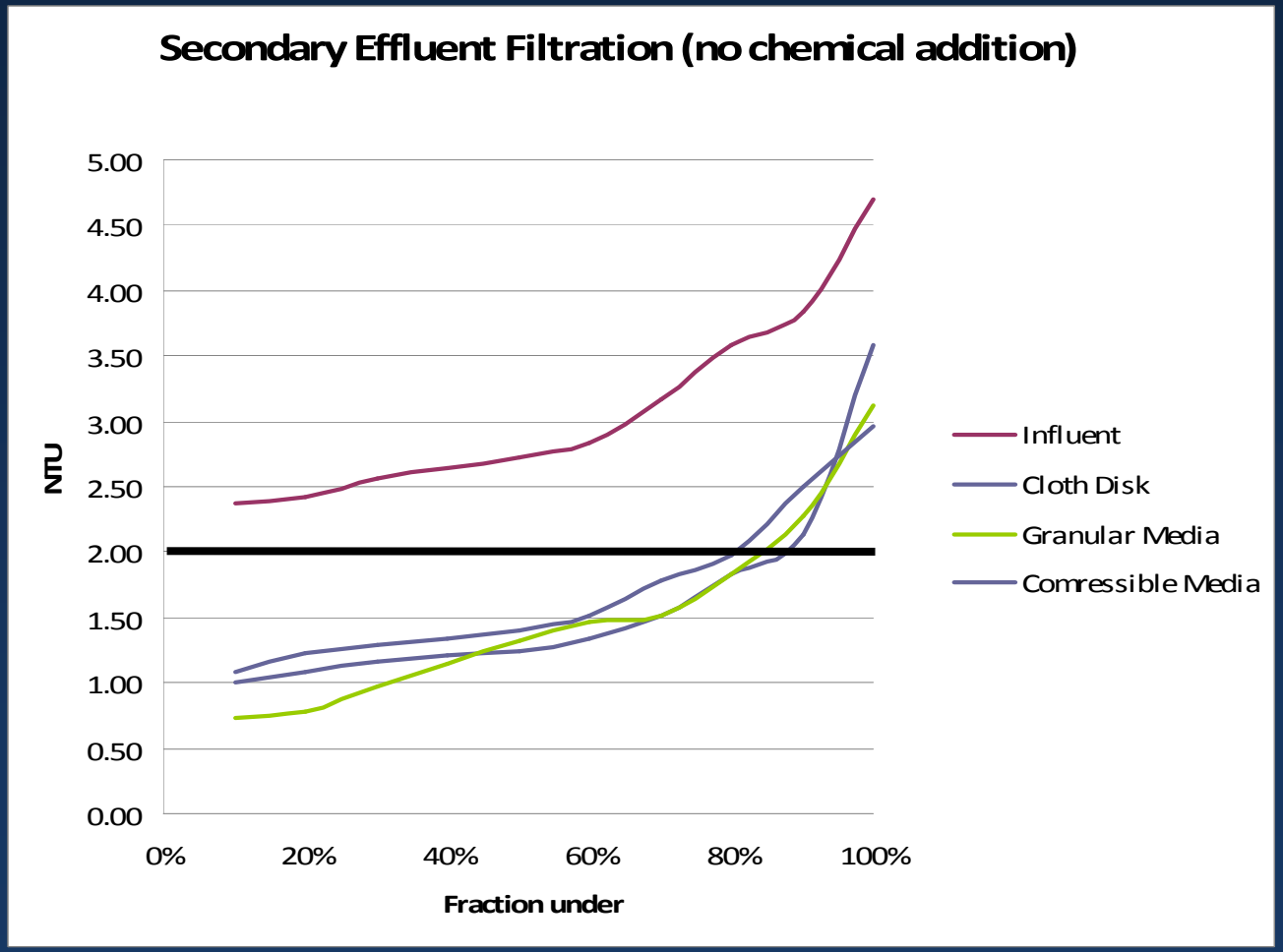


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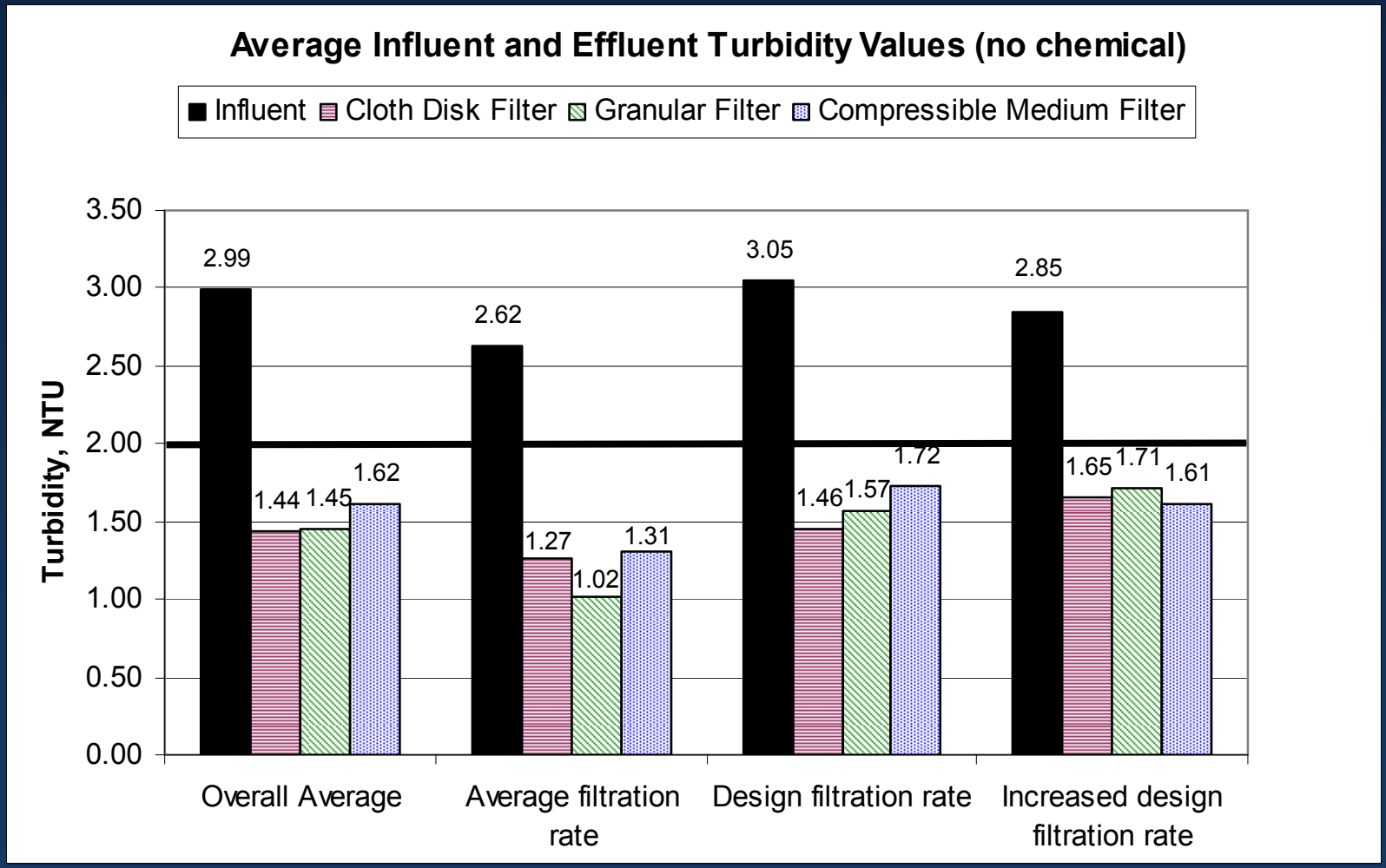
# Pilot Filter Testing Program - Summary of Average Influent and Effluent Turbidity Results

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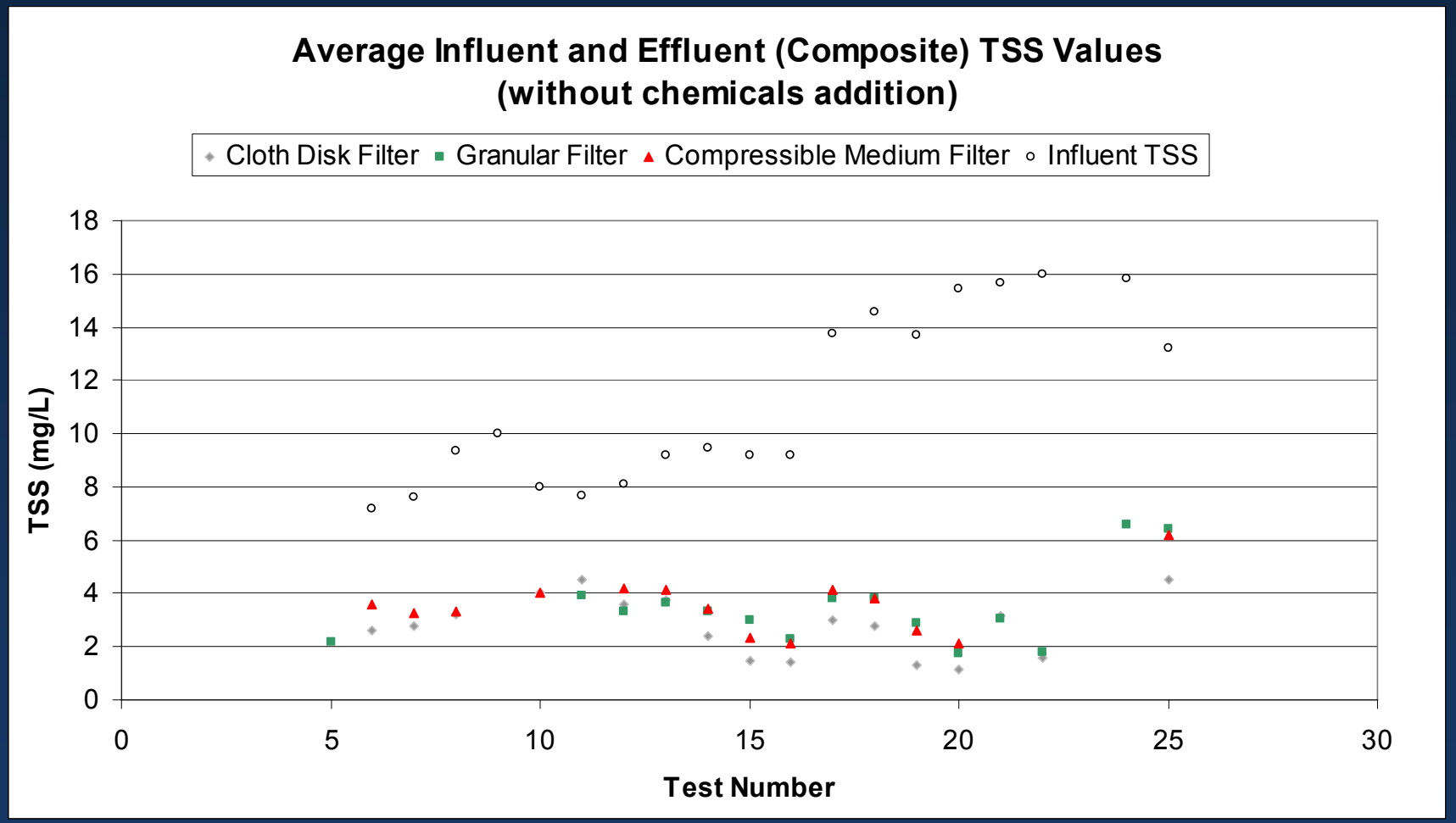
# Summary of Turbidity Results
# Secondary Effluent Filtration without Chemical addition

Class A recycled water turbidity requirements are expected to be achieved with all three filtration technologies tested for average secondary effluent turbidities up to approximately 5 NTU without chemical addition

The turbidity removal performance of the three filters was observed to be similar. Average turbidity removal efficiency was approximately 50 to 55 percent for all three filters

Average observed effluent turbidity values were less than 1.8 to 2.0 NTU for all three filtration technologies for the majority of the tests

# Pilot Filter Testing Program
# Average TSS (composite samples) Results for Individual Test

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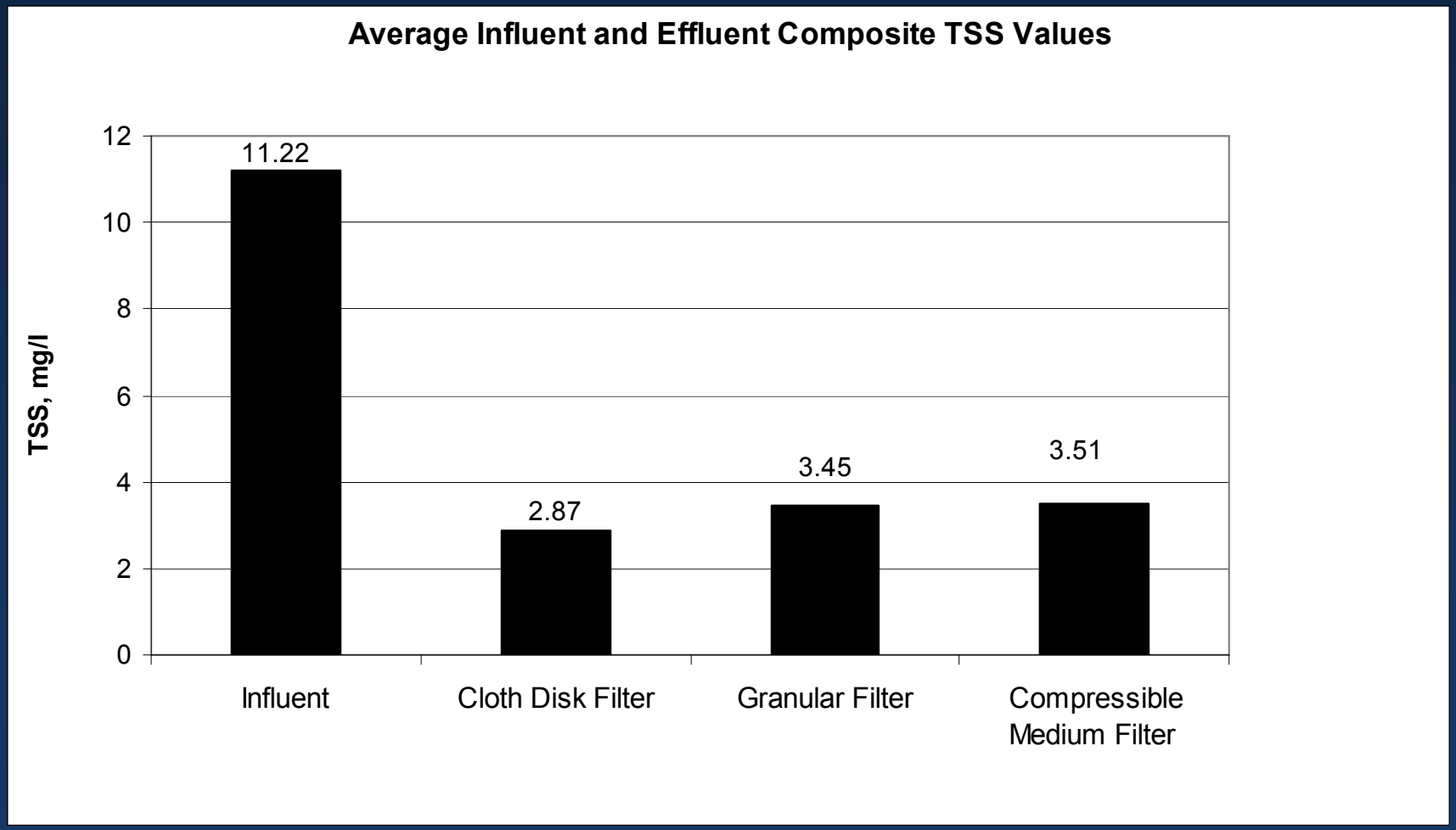
# Pilot Filter Testing Program
# Overall Average TSS (composite samples) Results

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# Summary of TSS Results
# Secondary Effluent Filtration without Chemical addition

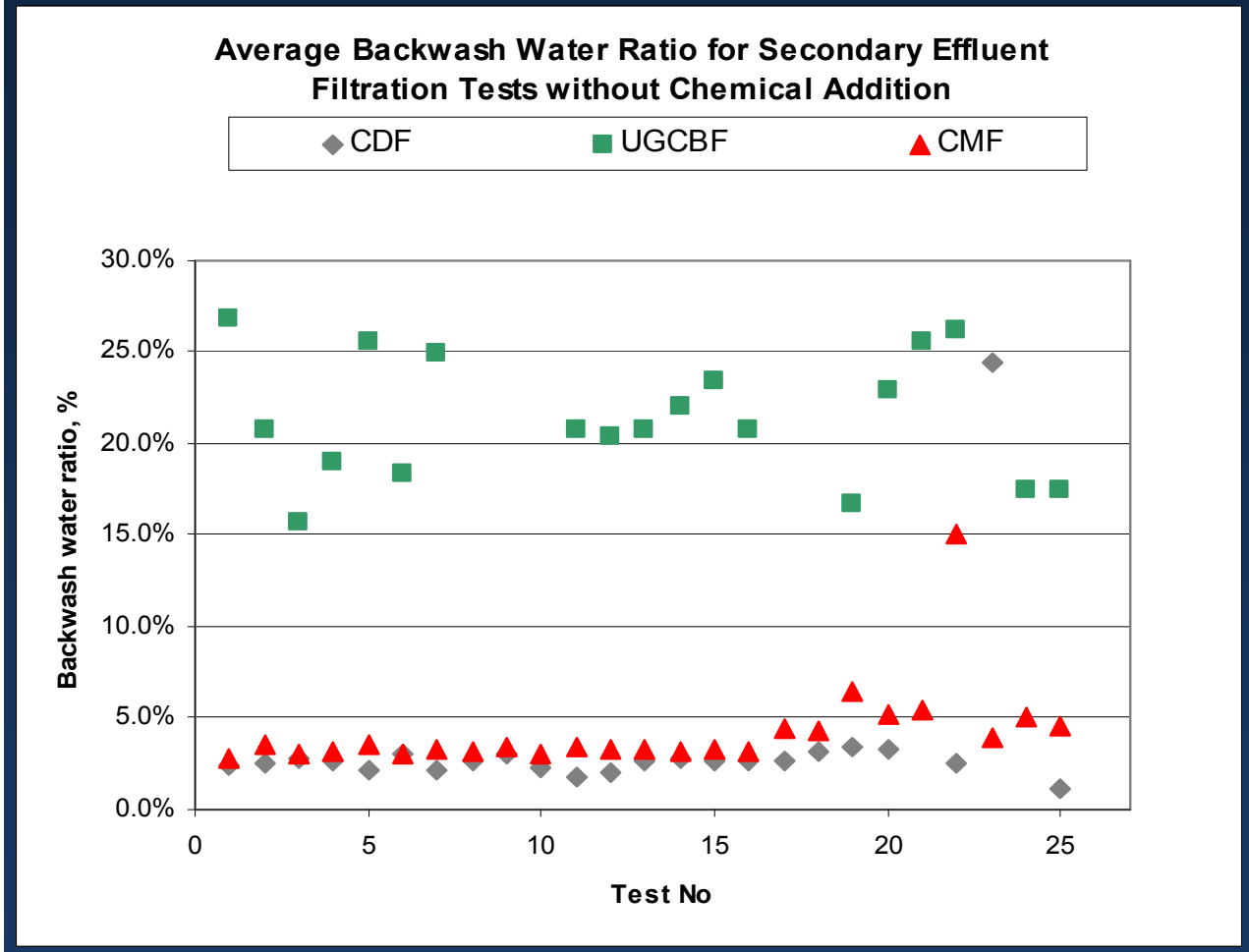
Future discharge TSS concentration requirements are expected to be achieved with all three filtration technologies for secondary effluent TSS values up to approximately 25 mg/L without chemical addition.

The average effluent TSS was less than 5 mg/L for all three filters for the majority of the tests during normal plant operating conditions.

The TSS removal performance of the three filters was observed to be similar. The removal performance of CDF appears to be approximately 15-20 percent higher compared to CMF and GCBF.

Without chemical addition, average TSS removal efficiency was between 60 and 70 percent.

# Summary of Backwash Water Ratio Results




For 10 mgd average plant flow:

% 2 Backwash Reject Ratio means 0.2 MGD returned to headworks : average plant flow increases to 10.2 mgd

% 15 Backwash Reject Ratio means 1.5 MGD returned to headworks : average plant flow increases to 11.5 mgd

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# Summary of Backwash Results
# Secondary Effluent Filtration without Chemical addition

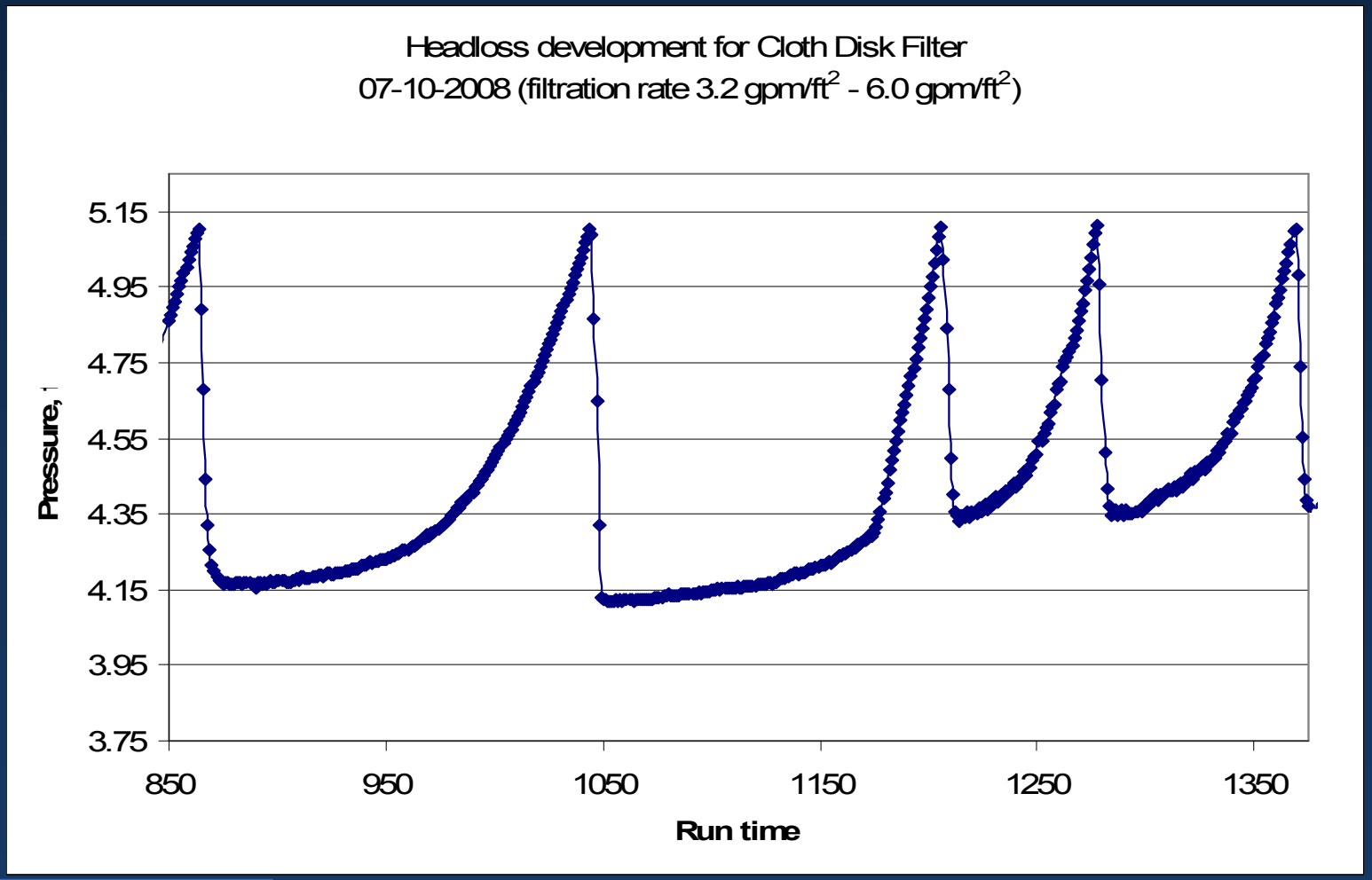
Backwash water ratio was observed to be between 1 percent and 5 percent for CMF and CDF for most tests. Average BWR was around 3 – 4 percent.

Backwash water ratio for GCBF was observed to be significantly higher compared to CMF and CDF. Average BWR was approximately 25 percent.

For actual installation with similar loading conditions, backwash water ratio is expected to be between 1 percent and 2 percent for CMF and CDF.

For actual installation with similar loading conditions, backwash water ratio is expected to be between 10 percent and 15 percent for GCBF.

# MWMC Cloth Disk Filter Headloss Development

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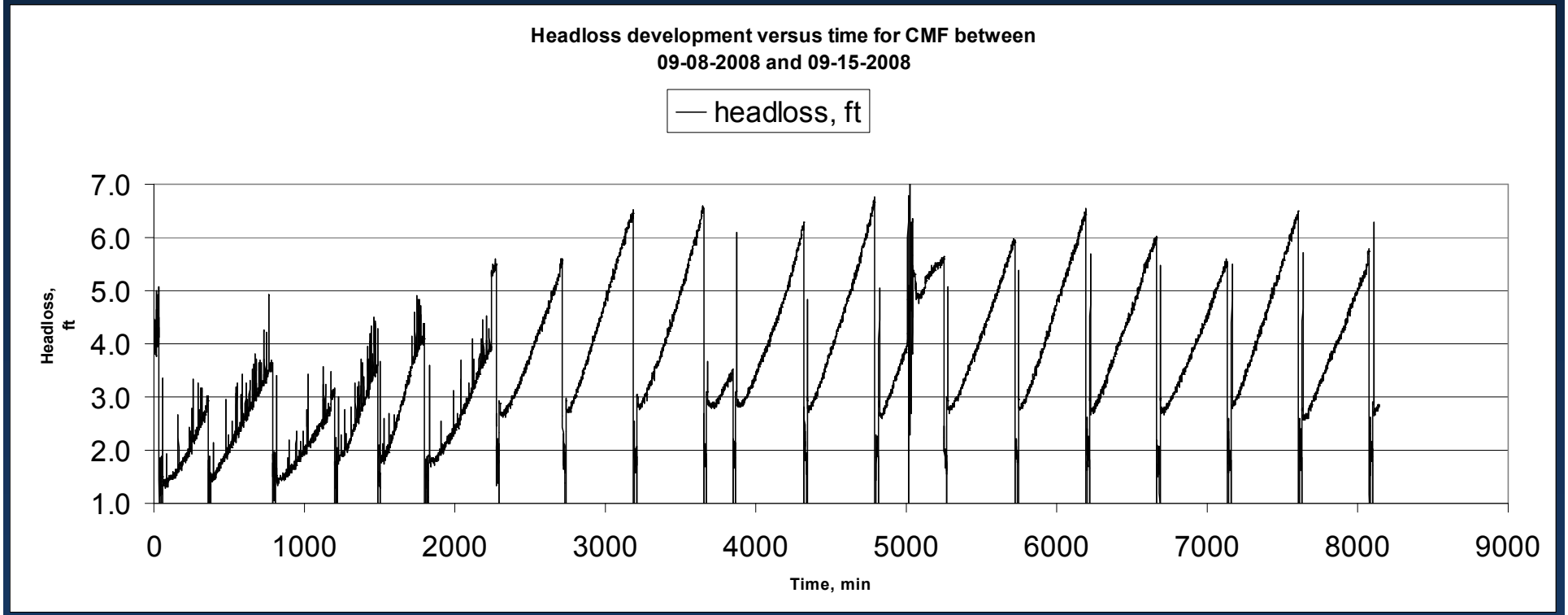
# MWMC Compressible Medium Filter Headloss Development

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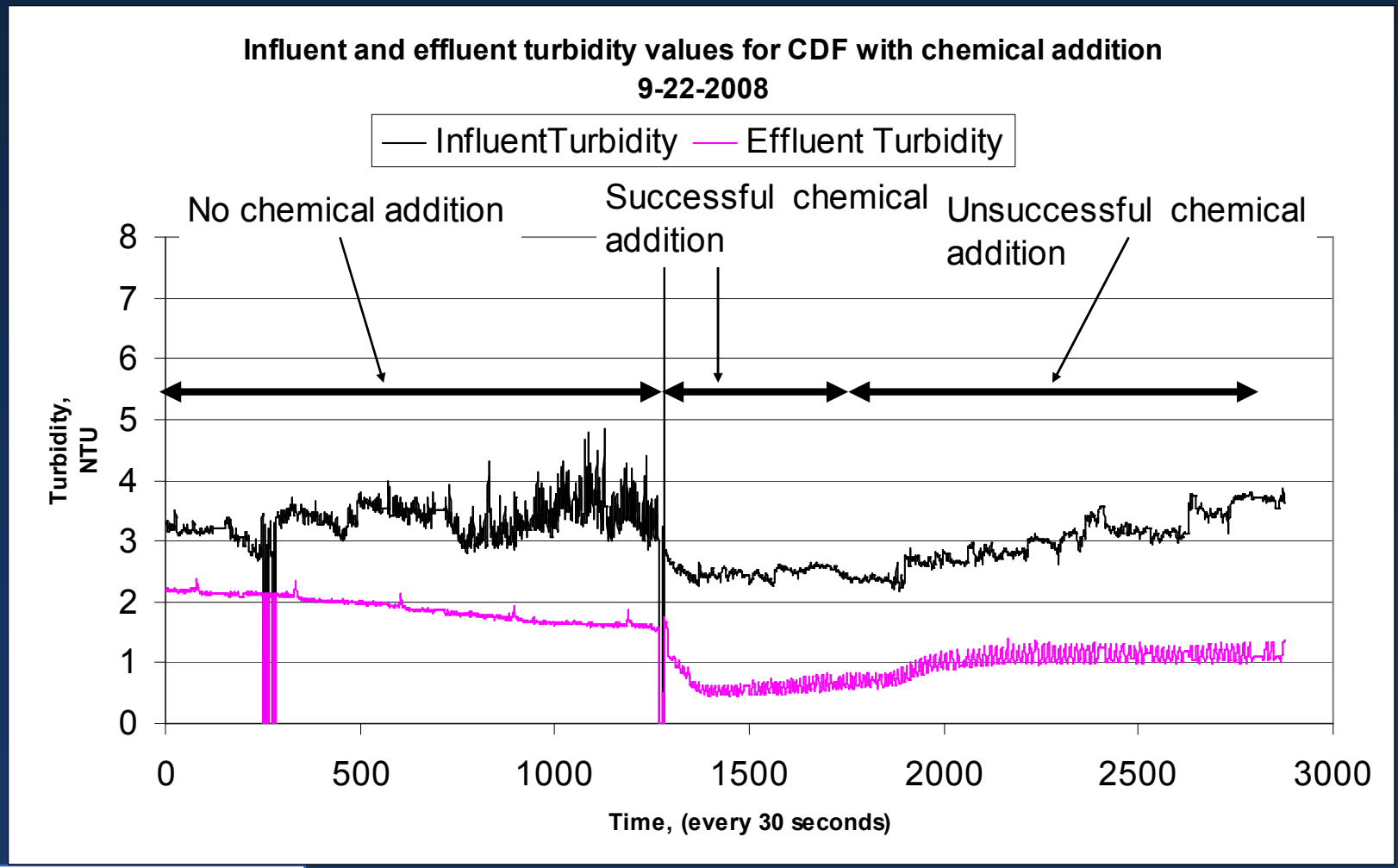
# Summary of Headloss Results
# Secondary Effluent Filtration without Chemical addition

Headloss development (through the medium) varies significantly between the three filtration technologies:

- CDF: Headloss development ranged between 0.4 feet and 0.9 feet with an average value of approximately 0.7 feet.
- CMF: Headloss development ranged between 0.6 feet and 4.2 feet with an average value of approximately 1.6 feet.
- GCBF: Headloss development ranged between 1.2 feet and 4.3 feet with an average value of approximately 2.3 feet.

# Secondary Effluent Filtration with Chemical Addition Cloth Disk Filter

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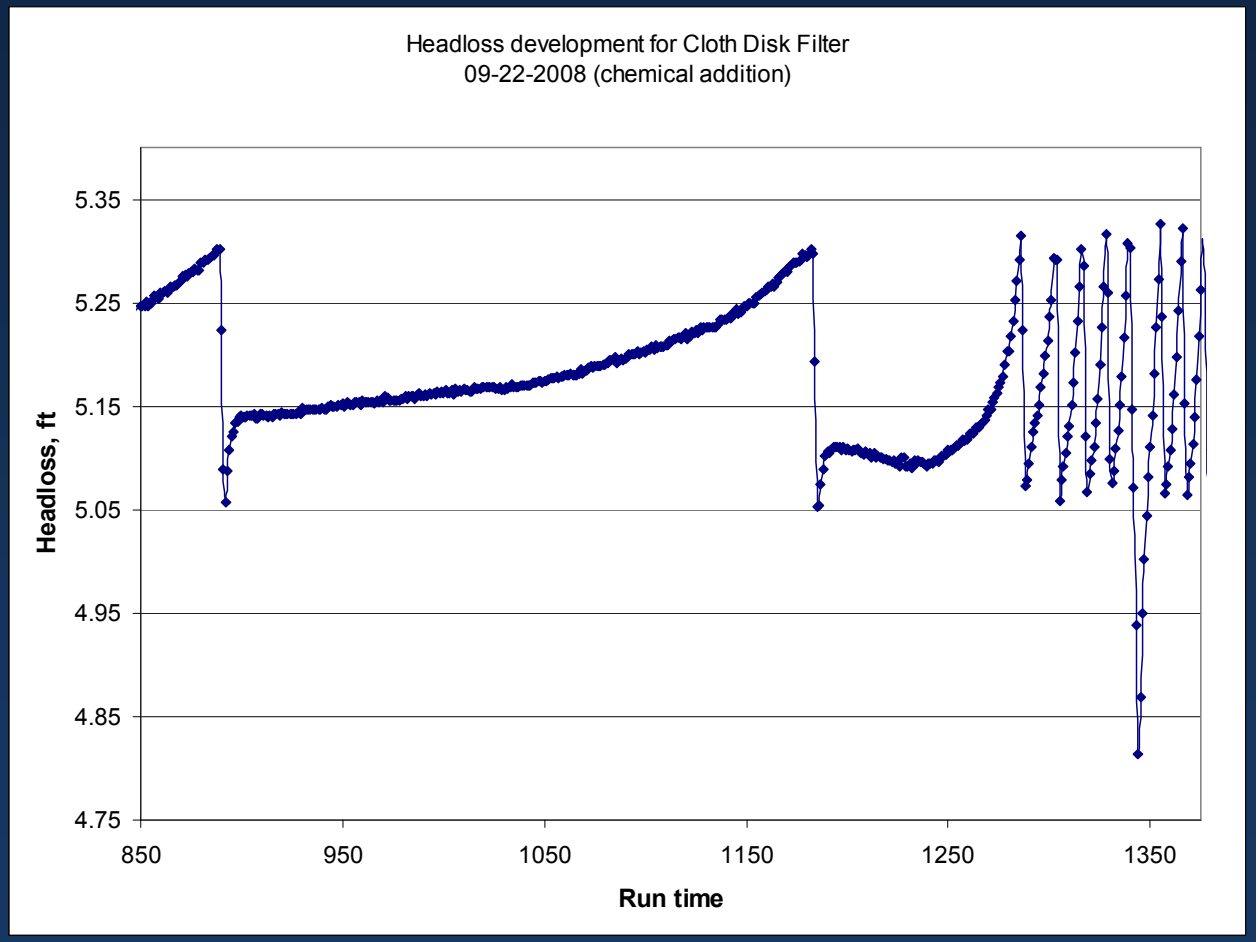
# Chemical addition tests
# Cloth Disk Filter - Impacts on headloss development

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# Summary of Chemical Addition Results

Turbidity removal efficiency increased to 70-75 percent with chemical addition for all three filters.

TSS removal efficiency increased to 80-85 percent with chemical addition for all three filters.

With chemical addition, compliance with Class A recycled water requirements is expected for secondary effluent turbidity values up to approximately 8 NTU.

With chemical addition, compliance with effluent TSS concentration requirements of 10 mg/L is expected for secondary effluent TSS values up to approximately 40 mg/L.

# Summary of Chemical Addition Results

Filtration removal efficiency increases with successful chemical addition, but it was observed to decline typically after 1 to 3 hours of chemical addition.

Backwash Water Ratio increased significantly for CMF and CDF (e.g., 5 to 10 times) as a result of chemical addition.

Medium blinding was observed to be a typical operational problem with chemical addition.

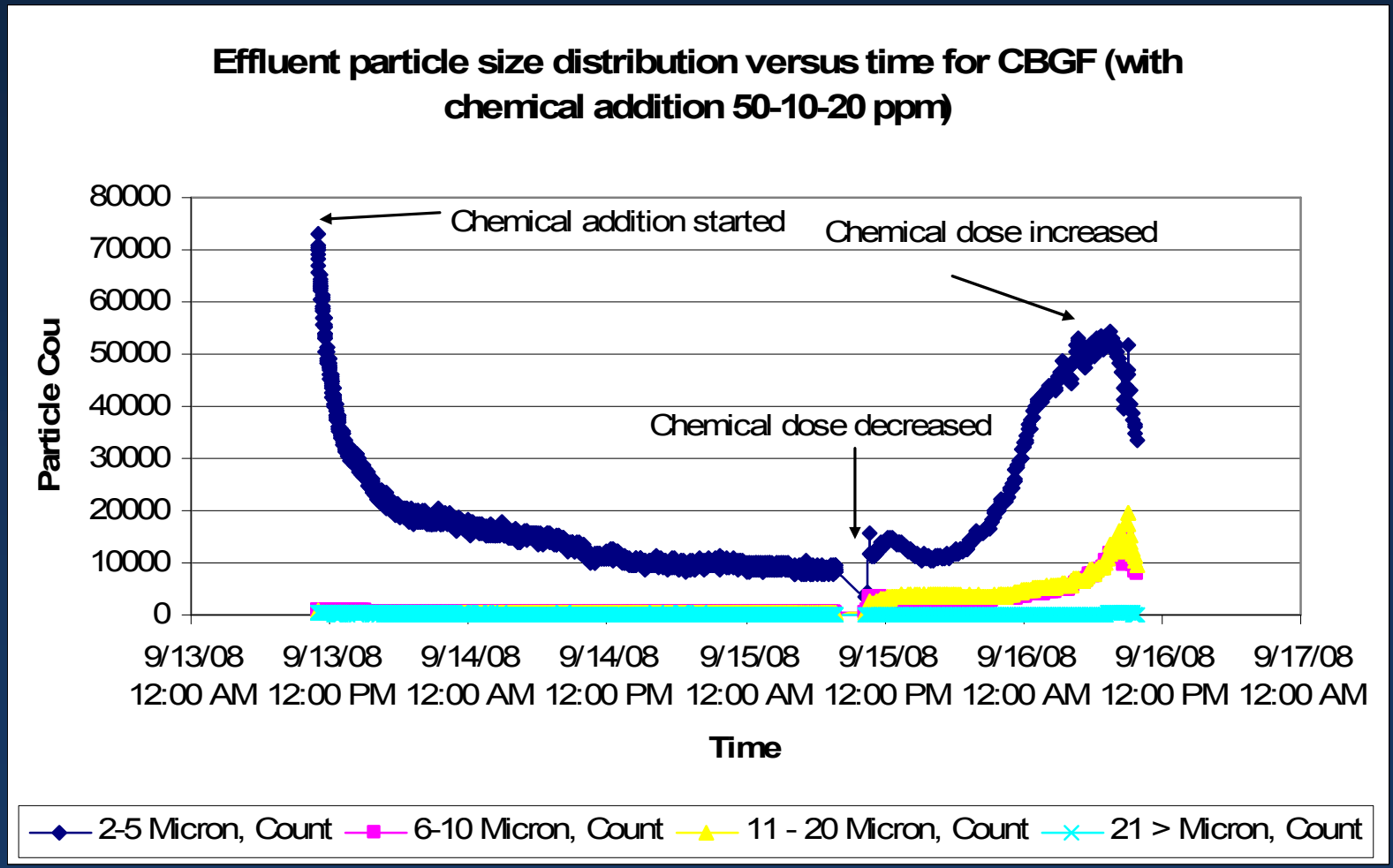
Chemical addition should be exercised only to meet recycled water requirements when necessary for a short period (e.g., one hour) during one filtration cycle.

# Evaluation of Filtration Performance
## Particle Size Distribution Modification

Especially important to ensure required disinfection efficiency

The removal of particles between ~ 5 and 15 to 20 micron in size is crucial to increase disinfection efficiency

# Upflow Granular Continuous Backwash Filter
# Effect of Chemical Addition on Particle Size Distribution

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# QUESTIONS & COMMENTS


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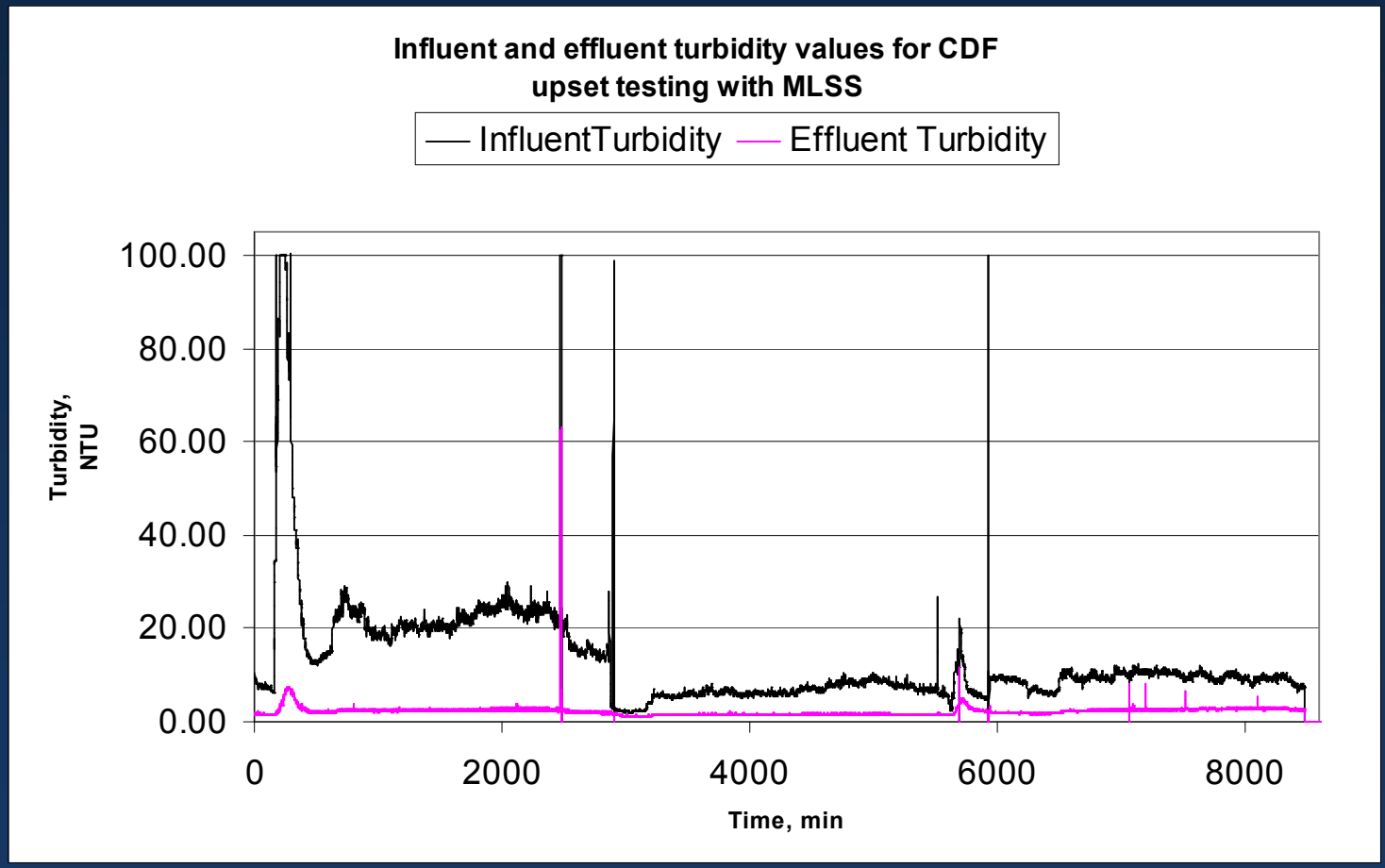
# Upset Simulation Turbidity Results for CDF

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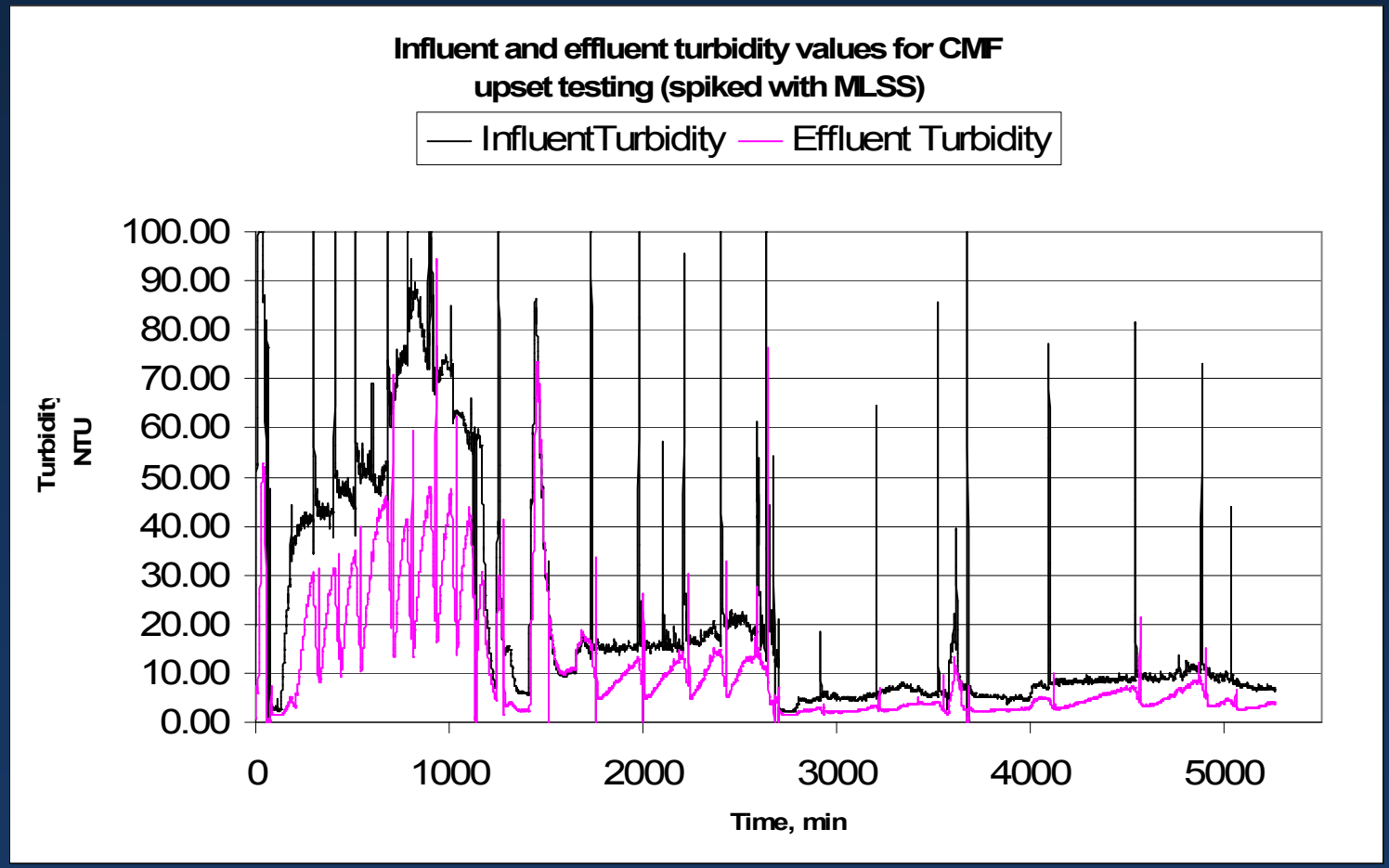
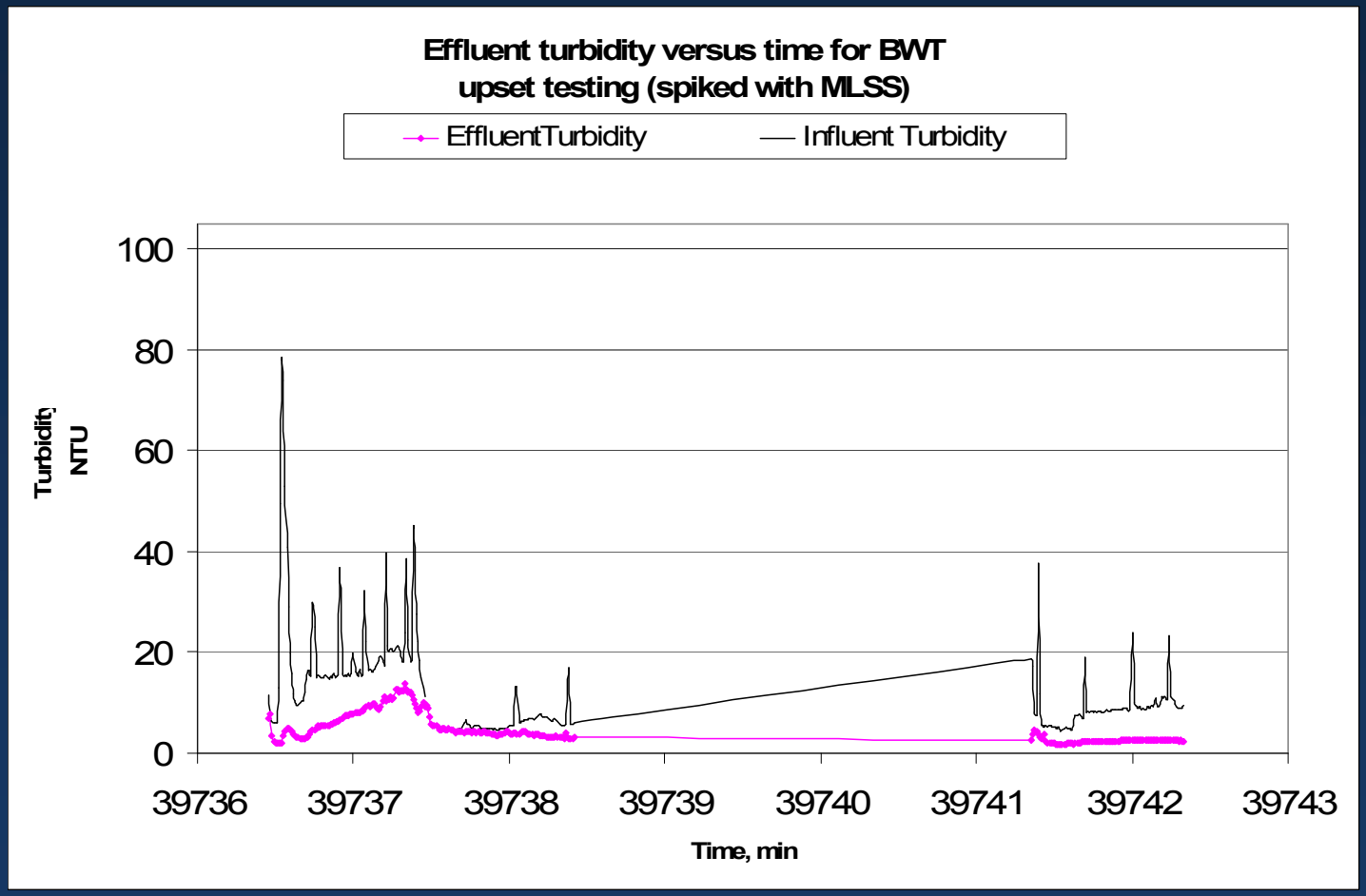
# Upset Simulation Turbidity Results for CMF



# Upset Simulation Turbidity Results for UGCBF

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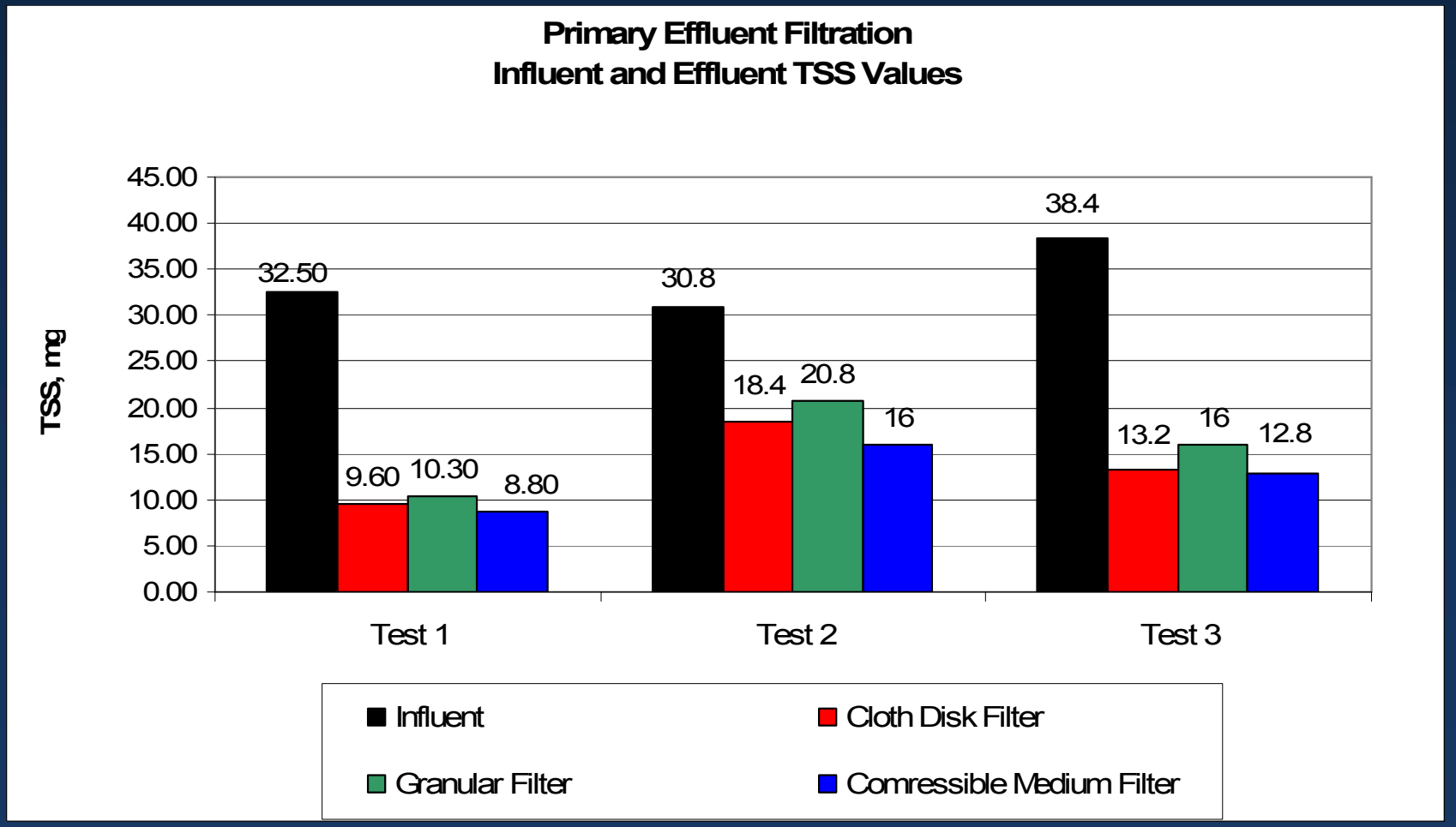
# Primary Effluent Filtration TSS Results



# Summary of Results
# Primary Effluent Filtration Tests

For primary effluent filtration, the filters' removal performances were comparable.

TSS removal efficiencies were observed to range between 40 percent and 75 percent for the three filtration technologies. The removal performance of CMF appears to be approximately 10 percent higher compared to CDF and GCBF.

For primary effluent filtration, the BWR ratios were observed to be between 15 and 20 percent for CDF and CMF. The BWR ratio was approximately 25 percent for GCBF.