Achieving Low Total Phosphorus with Cloth Media Filtration

Steve Stanish
Regional Manager
Presentation Outline

• Phosphorus removal using Cloth Media Filtration
• Cloth Media Filtration
• Keys to Success from Wisconsin Case Studies
• Other Applications
• Summary
Phosphorus Removal Using Cloth Media Filtration
Incorporate Phosphate into TSS

Source: J B Neethling, HDR Inc. WEFTEC 2006, Dallas
Phosphorus Removal

P : TSS Ratio

(Assumes 3% P in Biosolids)

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**Process Design**

**Biological Treatment**
- BOD: <10.0
- TSS: <10.0
- TN: <3.0
- TP: <0.6

**Filtration**
- BOD: <5.0
- TSS: <5.0
- TN: <3.0
- TP: ~0.1

**Ultrafiltration**
- BOD: <2.0
- TSS: ND
- TN: <3.0
- TP: <0.1
- Virus: 4 log

**Recycle and Reuse**
Importance of Operational Practices
Proper Chemical Injection Points

- Influent
- Screening
- Grit Chamber
- Primary Clarifier
- Waste Sludge
- Coagulant
- Clarifier
- Flash Mix
- Flocculation
- AquaDisk® Filter
- Effluent

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Phosphorus Removal

Chemical Dose

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Phosphorus Removal
Factors Affecting Required Chemical Dose

• Percent Removal
• Effluent Objective
• pH
• Contact Time
• Mixing
• Competing Reactions
Cloth Media Filtration
Pile Cloth Media

Pile Fibers

Support Backing

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Filtration Goals

• Maximize
  • Removal of solids
  • Hydraulic throughput

• Minimize
  • Backwash
  • Maintenance
Filtration Particle Removal Mechanisms

Surface Mechanism

Depth Filtration
L/D Ratio

Rapid Sand Filter

L/D = 500-1000

PES-14 Microfiber

L/D = 425-715

D = d_{10} = 0.6 mm

L = 300-600 mm

D ≈ 0.007 mm

L = 3-5 mm

When wet

So, what does all this mean?
Cloth Media Filter
How a Cloth Media Filter Works
How a Cloth Media Filter Works

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Pile Cloth Media
Media Options
Wisconsin Pilot Studies

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Pilot Studies
MD-4

• Single disk cloth media filter
• Online turbidity and orthophosphorus
• SCADA
• Fully equipped laboratory for on-site analysis
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**Piloting System**

- Online Ortho-P and Turbidity

- Fully equipped lab for on-site analysis
Pilot Studies
MD-4 Layout

Chemical Feed System (3 Chemicals) → Flocculation Basin → Cloth Media Filter
Pilot Studies

Outcome

• Three low TP pilots for < 75 μg/L

• We achieved our goal in each of the three pilots.

• Polymer addition, metal salt addition, and flocculation were needed to achieve our targets.
Pilot Studies
3 Keys to Success

1. Influent TP is the key to ensuring effluent TP

2. Soluble Non-Reactive TP is a significant factor when targeting ultra low TP

3. The 75 μg/L target is less than what most labs can reliably measure
Pilot Study
Key #1: Filter Influent Phosphorus Concentration
Pilot Study
Key #1: Filter Influent Phosphorus Concentration

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Phosphorus Removal
Key #2: Speciation Matters

- Total P
  - Soluble – P
  - Particulate P
    - Reactive
    - Non-Reactive
Pilot Studies
Key #2: Speciation Matters

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Pilot Study
Key #2: Speciation Matters

Graph showing phosphorus concentration over time from 12/5/2013 to 12/16/2013. The graph compares non-reactive soluble phosphorus, reactive soluble phosphorus, and non-soluble phosphorus against an effluent limit.
Pilot Studies
Key #3: Lab Analysis is Difficult

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Low TP
3 Keys

• Influent TP is the key to ensuring effluent TP

• Soluble Non-Reactive TP is a significant factor when targeting ultra low TP

• The 75 μg/L target is less than what most labs can reliably measure
Wet Weather Treatment
Wet Weather Treatment Development & Pilot Testing
Wet Weather Treatment
Definitions

• **Stormwater**
  • Road surface rainfall runoff flow

• **SSO – Sanitary Sewer Overflow**
  • Sanitary waste only
  • Excess flow discharge at WWTP or in the network

• **CSO – Combined Sewer Overflow**
  • Includes sanitary sewer flow and road surface rainfall runoff
  • Excess flow discharged at the WWTP or in the network
Wet Weather Treatment Options

- Disinfection – Chlorine / PAA/ UV
- Screening / Disinfection
- Swirl Concentrators or similar solutions
- Bag Filters
- Green Treatment / Wet Land Treatment
- Clarification
  - Conventional and/or HRC
- Filtration
  - Compressible Media Filters
  - AquaPrime Cloth Media Filters
Wet Weather Treatment

- The US EPA is pushing for treatment of CSO events
- Utilities are dealing with excessive flows due to inflow/infiltration due to the aging collection systems
- Many utilities are dealing with consent decrees
- Rulings against EPA on SSO blending
- Cloth media filtration can act as part of this treatment process

Ref: U.S. EPA ES-2: Report to Congress on the Impacts and Control of CSOs and SSOs
Road-Runoff Treatment

• About 95% of the forward flow is treated as effluent

• More than 85% TSS removal

• Approximately 65% reductions of heavy metals copper and zinc
RRWRD SSO Treatment
Test Results

Optifiber PES-14

- Influent
- Effluent
- Precipitation

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Rushville, IN Study
Dual Use – Tertiary/CSO
Rushville, IN

• 42 year old facility
• One active CSO Outfall (CSO 101) & Averages 11 CSO events/year
• 5-month study by AASI
• Under Construction / Startup 9/17
• Approved by IDEM
• UV Disinfection
CSO Study
Rushville, IN

• 42 year old facility
• One active CSO Outfall (CSO 101)
• Averages 11 CSO events/year
• Eliminate all untreated discharges from 1-yr, 1-hr events
• 5-month study by Aqua-Aerobic
Wet Weather
Typical Dual Arrangement

- Screened / Gritted Influent
- Primary Clarifier
- Secondary Process
- Secondary Clarifier
- Effluent

AquaPrime™
Dual Use Application
- Wet Weather
- Tertiary Treatment

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Wet Weather
Typical Dual Arrangement

Screened / Gritted Influent → Prima
ry 

Wet Weather Bypass

Secondary Process → Secondary Clarifier

Waste

Effluent

AquaPrime™
Dual Use Application
- Wet Weather
- Tertiary Treatment

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CSO Study
CSO 101 Outfall, Rushville IN

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CSO Study
Aqua MiniDisk® Nominal 100,000 gal/day Filter

- Flow Meters
- Chem Feed (Option)
- Composite Samplers
- On-line TSS
## Summary - TSS Removal

### Rushville CSO Study – All Events

<table>
<thead>
<tr>
<th>CSO Event</th>
<th>Date</th>
<th>ALL DATA</th>
<th>PEAK VALUES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Average Influent TSS (mg/L)</td>
<td>Average Effluent TSS (mg/L)</td>
</tr>
<tr>
<td>1</td>
<td>May 16, 2015</td>
<td>141</td>
<td>5.2</td>
</tr>
<tr>
<td>2</td>
<td>June 30, 2015</td>
<td>114</td>
<td>4.8</td>
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<tr>
<td>3</td>
<td>July 7, 2015</td>
<td>136</td>
<td>4.9</td>
</tr>
<tr>
<td>4</td>
<td>July 12, 2015</td>
<td>74</td>
<td>3.8</td>
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<tr>
<td>5</td>
<td>July 13, 2015</td>
<td>24</td>
<td>2.0</td>
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</table>

Alum dosed during week 1 and 2 only
TSS Removal – Event 1
Rushville CSO Study (May 16, 2015)

Alum Added
TSS Removal – Event 2
Rushville CSO Study (June 30, 2015)

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TSS Removal – Event 3
Rushville CSO Study (July 7, 2015)

No Chemicals Added
TSS Removal – Event 4
Rushville CSO Study (July 12, 2015)

No Chemicals Added
TSS Removal – Event 5
Rushville CSO Study (July 13, 2015)

No Chemicals Added
## Summary – BOD$_5$ Removal

Rushville CSO Study – All Events

<table>
<thead>
<tr>
<th>CSO Event</th>
<th>Date</th>
<th>ALL DATA</th>
<th>PEAK VALUES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Average Influent BOD (mg/L)</td>
<td>Average Effluent BOD (mg/L)</td>
</tr>
<tr>
<td>1</td>
<td>May 16, 2015</td>
<td>87</td>
<td>3.5</td>
</tr>
<tr>
<td>2</td>
<td>June 30, 2015</td>
<td>37</td>
<td>4.3</td>
</tr>
<tr>
<td>3</td>
<td>July 7, 2015</td>
<td>55</td>
<td>18.2</td>
</tr>
<tr>
<td>4</td>
<td>July 12, 2015</td>
<td>60</td>
<td>14.5</td>
</tr>
<tr>
<td>5</td>
<td>July 13, 2015</td>
<td>73</td>
<td>18.1</td>
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</tbody>
</table>

Alum dosed during week 1 and 2 only
BOD$_5$ Removal – Event 1
Rushville CSO Study (May 16, 2015)

Alum Added
**BOD$_5$ Removal – Event 2**
Rushville CSO Study (June 30, 2015)

No Chemicals Added

Alum Added
BOD$_5$ Removal – Event 3
Rushville CSO Study (July 7, 2015)

No Chemicals Added
BOD$_5$ Removal – Event 4
Rushville CSO Study (July 12, 2015)

No Chemicals Added
BOD$_5$ Removal – Event 5
Rushville CSO Study (July 13, 2015)

No Chemicals Added
## Rushville, IN

### Loading Summary

<table>
<thead>
<tr>
<th>Condition</th>
<th>Rainfall (in)</th>
<th>Eff WW Flow (MG)</th>
<th>TSS Load (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015 Annual Avg Daily WWTP Dischg</td>
<td></td>
<td>1.54</td>
<td>70.4</td>
</tr>
<tr>
<td>2015 Total Annual WWTP Dischg</td>
<td>51.21</td>
<td>562</td>
<td>25,696</td>
</tr>
<tr>
<td>Avg. Annual CSO in LTCP</td>
<td></td>
<td></td>
<td>30,584</td>
</tr>
<tr>
<td>2015 Annual WWTP &amp; Avg Annual CSO Dischg</td>
<td>600</td>
<td></td>
<td>56,280</td>
</tr>
<tr>
<td>Annual Disc Filter Trt of CSO Flow</td>
<td>38.2</td>
<td></td>
<td>1,274</td>
</tr>
<tr>
<td>2015 Total Annual WWTP Eff with Tertiary Filter Trt</td>
<td>562</td>
<td></td>
<td>7,709</td>
</tr>
<tr>
<td>2015 Annual WWTP Filtered Eff + CSO Filter Eff</td>
<td>600</td>
<td></td>
<td>8,983</td>
</tr>
</tbody>
</table>

Disc Filtering of all Flow Reduction over NPD-16 CSO Trt Fac 73%

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## Rushville, IN

### Loading Summary

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Rainfall (in.)</th>
<th>Eff WW Flow (MG)</th>
<th>TSS Load (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015 Annual Avg Daily WWTP Dischg</td>
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<td>562</td>
<td>25,696</td>
</tr>
<tr>
<td>Avg. Annual CSO in LTCP</td>
<td></td>
<td></td>
<td>30,584</td>
</tr>
<tr>
<td><strong>2015 Annual WWTP &amp; Avg Annual CSO Dischg</strong></td>
<td><strong>600</strong></td>
<td><strong>56,280</strong></td>
<td></td>
</tr>
<tr>
<td>Annual CMF Filter Trt of CSO Flow</td>
<td>38.2</td>
<td>1,274</td>
<td></td>
</tr>
<tr>
<td>2015 Total Annual WWTP Eff with Tertiary Filter Trt</td>
<td>562</td>
<td>7,709</td>
<td></td>
</tr>
<tr>
<td><strong>2015 Annual WWTP Filtered Eff + CSO Filter Eff</strong></td>
<td><strong>600</strong></td>
<td><strong>8,983</strong></td>
<td></td>
</tr>
</tbody>
</table>

CMF Filtering of all Flow Reduction over 2015 Existing Trt Fac

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**Wet Weather Treatment**

**Rushville Dual Treatment Flow Scheme**

- 1.5 MGD Ave Dry Weather Capacity
- 4 MGD Peak Plant Capacity
- 12 MGD Storm Event

- Eliminates Secondary Expansion
- Dual application treatment allows the customer to meet NPDES

**Diagram:**
- 12 MGD
- 4 MGD
- 1.5 MGD
- Primary Clarifier
- 4 MGD
- 1.5 MGD
- Secondary Process / Clarification
- 0.5 MGD (Waste Flow)
- 12 MGD
- 4 MGD
- 1.5 MGD
- AquaPrime™
- 12 MGD
- 1.5 MGD
- 4 MGD

Provisioning Adaptive Water Management Solutions
## Rushville, IN Loading Summary

### Rushville WWTP and CSO Discharge Loadings to Flatrock River

<table>
<thead>
<tr>
<th>Condition</th>
<th>Rainfall (in)</th>
<th>Eff WW Flow (MG)</th>
<th>CBOD₃ Load (lbs)</th>
<th>TSS Load (lbs)</th>
<th>P Load (lbs)</th>
<th>Ammonia Load (lbs)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015 Annual Avg Daily WWTP Dischg</td>
<td>1.54</td>
<td>32.3</td>
<td>70.4</td>
<td>47.52</td>
<td>1.39</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015 Total Annual WWTP Dischg</td>
<td>51.21</td>
<td>562</td>
<td>11,790</td>
<td>25,696</td>
<td>17,345</td>
<td>507</td>
<td>No P Removal in Permit</td>
</tr>
<tr>
<td>Avg. Annual CSO in LTCP</td>
<td>38.2</td>
<td>18,160</td>
<td>30,584</td>
<td>414.2</td>
<td>733</td>
<td>Estimated Avg Annual CSO Volume in LTCP</td>
<td></td>
</tr>
<tr>
<td>2015 Annual WWTP &amp; Avg Annual CSO Dischg</td>
<td>600</td>
<td>29,949</td>
<td>56,280</td>
<td>17,759</td>
<td>1,240</td>
<td>Avg ammonia dischg = 3.4 lb/day</td>
<td></td>
</tr>
<tr>
<td>NPD-16 Trt Facility CSO Dischg</td>
<td>22.4</td>
<td>3,088</td>
<td>6,994</td>
<td>46.1</td>
<td>125</td>
<td>15.8 MG Gets full WWTP Treatment (Use Goshen CSO Trt Fac Performance)</td>
<td></td>
</tr>
<tr>
<td>2015 Annual WWTP + NPD-016 Trt Fac Dischg</td>
<td>600</td>
<td>15,209</td>
<td>33,413</td>
<td>3,809</td>
<td>646</td>
<td>With Future WWTP P Eff ≈ 0.8 mg/l</td>
<td></td>
</tr>
<tr>
<td>Annual Disc Filter Trt of CSO Flow</td>
<td>38.2</td>
<td>956</td>
<td>1,274</td>
<td>38.2</td>
<td>605</td>
<td>(No disinfection byproducts with UV CSO trt and 1.9 mg/l ammonia CSO eff assumed)</td>
<td></td>
</tr>
<tr>
<td>2015 Annual WWTP + Disc Filter Trt of CSO Flow</td>
<td>600</td>
<td>12,746</td>
<td>26,970</td>
<td>3,789</td>
<td>1,112</td>
<td>With Future WWTP P Eff ≈ 0.8 mg/l</td>
<td></td>
</tr>
<tr>
<td>CSO Disc Filter Reduction over NPD-16 CSO Trt Fac</td>
<td>16%</td>
<td>19%</td>
<td>1%</td>
<td>-72%</td>
<td>Avg ammonia dischg = 3 lb/day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015 Total Annual WWTP Eff with Tertiary Filter Trt</td>
<td>562</td>
<td>8,842</td>
<td>7,709</td>
<td>1,406.4</td>
<td>507</td>
<td>Assumes alum added for WWTP P removal</td>
<td></td>
</tr>
<tr>
<td>2015 Annual WWTP Filtered Eff + CSO Filter Eff</td>
<td>600</td>
<td>9,798</td>
<td>8,983</td>
<td>1,445</td>
<td>1,112</td>
<td>Avg ammonia dischg = 3 lb/day</td>
<td></td>
</tr>
</tbody>
</table>

Disc Filtering of all Flow Reduction over NPD-16 CSO Trt Fac | 36% | 73% | 62% | -72% |

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### Providing Adaptive Water Management Solutions
## Summary

### Rushville CSO Study – All Events

<table>
<thead>
<tr>
<th>Parameter</th>
<th>With Alum Addition</th>
<th>Without Chemical Addition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Influent (mg/L)</td>
<td>Effluent (mg/L)</td>
</tr>
<tr>
<td>Total P</td>
<td>1.29</td>
<td>0.11</td>
</tr>
<tr>
<td>Turbidity</td>
<td>43.9</td>
<td>1.9</td>
</tr>
<tr>
<td>UVT</td>
<td>64.3</td>
<td>86.9</td>
</tr>
<tr>
<td>NH4-N</td>
<td>2.5</td>
<td>1.9</td>
</tr>
</tbody>
</table>

Alum dosed during week 1 and 2 only
Rushville, IN

Outcome

- Cloth media filtration was approved by IDEM for dual tertiary / CSO treatment
- Full-scale system is in design with an expected start up Sept 2017
- Filters will treat secondary effluent in normal operation (dry conditions)
- Followed by UV disinfection
Wet Weather
PEF SSO Study
Arkansas
Arkansas Wet Weather Project
Tertiary / PEF SSO Application

- SSO Project with side stream treatment
- 36 MGD Tertiary
- 58 MGD Aux. Wet Weather Treatment
- Max flow of 94 MGD
- UV Disinfection
- Permitted by ADEQ
Providing Adaptive Water Management Solutions

**PEF Pilot Study**

**TSS Removal**

- **TSS Removal:** 50 to 78%

### TSS Removal (PEF)

- **Influent TSS (mg/L)**
- **Effluent TSS (mg/L)**
PEF Pilot Study

Results

BOD Removal (PEF)

- Composite BOD Concentration (mg/L)
  - Influent BOD
  - Effluent BOD

Effluent UVT (mJ/cm²)

- Influent UVT (mJ/cm²)
  - Effluent UVT (mJ/cm²)

P Removal (PEF)

- Composite P Concentration (mg/L)
  - Influent Total Phosphorus (mg/L)
  - Effluent Total Phosphorus (mg/L)

Providing Adaptive Water Management Solutions
PEF Pilot Study
Disinfection Results

- PAA Contact Time: 8 min.
- UV Dosage: 20 mJ/cm².
Wet Weather Treatment
Arkansas Dual Treatment Flow Scheme

- 12 MGD Ave Dry Weather Capacity
- 36 MGD Peak Plant Capacity
- 94 MGD Storm Event

- Eliminated Secondary Expansion
- Side-stream treatment allow the customer to meet NPDES

Providing Adaptive Water Management Solutions
## Est. Performance

<table>
<thead>
<tr>
<th>Total Facility Flow (MGD)</th>
<th>Split (MGD)</th>
<th>Number of WW Events</th>
<th>Type</th>
<th>Influent TSS (mg/L)</th>
<th>Treatment Type</th>
<th>Effluent TSS (mg/L)</th>
<th>Daily / Event Discharge Saving (lbs TSS)</th>
<th>TSS Reduction Per year (lbs TSS)</th>
<th>Est. Effluent (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>15</td>
<td>0</td>
<td>Secondary</td>
<td>10</td>
<td>Tertiary</td>
<td>5</td>
<td>625</td>
<td>226,078</td>
<td>5</td>
</tr>
<tr>
<td>30</td>
<td>30</td>
<td>0</td>
<td>Secondary</td>
<td>15</td>
<td>Tertiary</td>
<td>5</td>
<td>2,498</td>
<td>904,312</td>
<td>5</td>
</tr>
<tr>
<td>36</td>
<td>36</td>
<td>0</td>
<td>Secondary</td>
<td>20</td>
<td>Tertiary</td>
<td>5</td>
<td>4,497</td>
<td>1,627,762</td>
<td>5</td>
</tr>
<tr>
<td>50</td>
<td>36</td>
<td>0</td>
<td>Secondary</td>
<td>20</td>
<td>Tertiary</td>
<td>5</td>
<td>4,497</td>
<td>1,627,762</td>
<td>9.2</td>
</tr>
<tr>
<td>14</td>
<td>5</td>
<td>5</td>
<td>Overflow</td>
<td>85</td>
<td>SSO</td>
<td>20</td>
<td>7,578</td>
<td>37,888</td>
<td></td>
</tr>
<tr>
<td>72</td>
<td>36</td>
<td></td>
<td>Secondary</td>
<td>20</td>
<td>Tertiary</td>
<td>5</td>
<td>4,497</td>
<td>1,627,762</td>
<td>12.5</td>
</tr>
<tr>
<td>36</td>
<td>5</td>
<td>5</td>
<td>Overflow</td>
<td>85</td>
<td>SSO</td>
<td>20</td>
<td>19,485</td>
<td>97,426</td>
<td></td>
</tr>
<tr>
<td>94</td>
<td>36</td>
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<td>Secondary</td>
<td>20</td>
<td>Tertiary</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td>58</td>
<td>3</td>
<td>Overflow</td>
<td>85</td>
<td>SSO</td>
<td>20</td>
<td>31,393</td>
<td>94,178</td>
<td></td>
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</tr>
</tbody>
</table>
### Annual Load Reduction To Receiving Stream

<table>
<thead>
<tr>
<th>Annual Daily Average Facility Flow (MGD)</th>
<th>Number of WW Events</th>
<th>Average Event Flow (MGD)</th>
<th>Influent TSS (mg/L)</th>
<th>Treatment Type</th>
<th>Effluent TSS (mg/L)</th>
<th>Daily / Event Discharge Saving (lbs TSS)</th>
<th>Tertiary TSS Reduction Per year (lbs TSS)</th>
<th>Annual % Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>0</td>
<td>0</td>
<td>20</td>
<td>Tertiary</td>
<td>5</td>
<td>3,123</td>
<td>1,139,758</td>
<td>60%</td>
</tr>
<tr>
<td>0</td>
<td>13</td>
<td>42.3</td>
<td>85</td>
<td>SS0</td>
<td>20</td>
<td>22,899</td>
<td>297,690</td>
<td>16%</td>
</tr>
</tbody>
</table>

**Est. Reduction 76% Annually**
PEF Pilot Study

TSS Removal

TSS Removal (PEF)

50 to 75% Removal

Providing Adaptive Water Management Solutions
Providing Adaptive Water Management Solutions
SSO Study
Little Rock Wastewater

• PEF & Tertiary Treatment
• Averages 13 SSO events/year
• Eliminate all untreated discharges & improve water quality
• 1 – Month Study
### Little Rock Flows

#### Wet Weather

<table>
<thead>
<tr>
<th>Month</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>10.3</td>
<td>166.6</td>
<td>46.3</td>
<td>40.1</td>
</tr>
<tr>
<td>Feb</td>
<td>13.9</td>
<td>28.9</td>
<td>40.6</td>
<td>0.0</td>
</tr>
<tr>
<td>Mar</td>
<td>160.5</td>
<td>23.1</td>
<td>21.3</td>
<td>304.6</td>
</tr>
<tr>
<td>Apr</td>
<td>0.0</td>
<td>89.3</td>
<td>89.1</td>
<td>15.4</td>
</tr>
<tr>
<td>May</td>
<td>0.0</td>
<td>10.6</td>
<td>2.7</td>
<td>145.6</td>
</tr>
<tr>
<td>Jun</td>
<td>0.0</td>
<td>75.8</td>
<td>45.1</td>
<td>3.0</td>
</tr>
<tr>
<td>Jul</td>
<td>0.0</td>
<td>0.0</td>
<td>8.9</td>
<td>#N/A</td>
</tr>
<tr>
<td>Aug</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>#N/A</td>
</tr>
<tr>
<td>Sep</td>
<td>46.8</td>
<td>0.0</td>
<td>0.0</td>
<td>#N/A</td>
</tr>
<tr>
<td>Oct</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>#N/A</td>
</tr>
<tr>
<td>Nov</td>
<td>4.3</td>
<td>22.5</td>
<td>0.0</td>
<td>#N/A</td>
</tr>
<tr>
<td>Dec</td>
<td>11.2</td>
<td>100.3</td>
<td>0.0</td>
<td>#N/A</td>
</tr>
<tr>
<td>Total</td>
<td>247</td>
<td>517</td>
<td>254</td>
<td>509*</td>
</tr>
</tbody>
</table>

(* thru Jun)
A Flow Scenario
Dual Treatment

<table>
<thead>
<tr>
<th></th>
<th>Flow (MGD)</th>
<th>Backwash %</th>
<th>Waste (MGD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bypass</td>
<td>36</td>
<td>8%</td>
<td>3</td>
</tr>
<tr>
<td>Secondary Effluent</td>
<td>36</td>
<td>3%</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>72</td>
<td>5%</td>
<td>4</td>
</tr>
</tbody>
</table>

Bypass 36 8% 3
Secondary Effluent 36 3% 1
Total 72 5% 4

Providing Adaptive Water Management Solutions
Little Rock, AR
Adams Field WWTP

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Little Rock, AR
Adams Field WWTP

Providing Adaptive Water Management Solutions
Municipal Sewer District of Greater Cincinnati (MSDGC)
Remote Site Study
MSD Greater Cincinnati - MSDGC
Remote Site - CSO Treatment

• Average Overflows Totaling >11.5 billion annually
• System is comprised of SSO and CSO network areas
• 13 Large Overflow Sites needing additional treatment – presently screening and disinfection
• Investigating new solutions which are easy to startup and operate at remote sites.

<table>
<thead>
<tr>
<th>Value</th>
<th>TSS (mg/L)</th>
<th>CBOD₅ (mg/L)</th>
<th>E. Coli (ct/100 mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min</td>
<td>60</td>
<td>10</td>
<td>10⁵</td>
</tr>
<tr>
<td>Avg</td>
<td>154.6</td>
<td>39.2</td>
<td>10⁶</td>
</tr>
<tr>
<td>Max</td>
<td>470</td>
<td>91</td>
<td>10⁷</td>
</tr>
</tbody>
</table>
**MSD Greater Cincinnati - MSDGC**

Remote Site - CSO Treatment

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

<table>
<thead>
<tr>
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<td>10⁷</td>
</tr>
</tbody>
</table>

Providing Adaptive Water Management Solutions
**Wet Weather – Remote Site**

**Typical Arrangement**

- **50 MGD (SSO / CSO Flow)**
- **Excess Flow**
- **60 MGD**
- **10 MGD**

**Wet Weather Bypass/Overflow**

- **Screening/Grit**
- **AquaPrime™**
- **Disinfection**
- **Discharge**
- **48 MGD (Treated)**

- **2 MGD (Waste Flow)**
- **12 MGD**

**WW Flow**

**WW Trunk Line**

- **10 MGD**

- **High quality effluent - 15 to 40 mg/L typically**
- **Treatment with no chemical addition**
- **Unmanned operation / remote operation**
- **Simple to startup & shutdown**
MSDGC Remote Site
CSO Treatment

TSS Removal - CMF Filter Pilot

- Influent TSS
- CMF Effluent TSS
- CMF TSS Removal

Providing Adaptive Water Management Solutions
MSDGC Remote Site
CSO Treatment

Event Five (9/26/2016)

- HLR: Hectoliters per minute per square foot (hlr/ft²)
- SLR: Short Living Rainwater

- TSS (Total Suspended Solids) Removal (%)
- CBOD (Chemically Bound Oxygen Demand) Removal (%)
- UVT (%)

---

Influent  Effluent  Removal

---

Influent  Effluent
MSDGC Remote Site
CSO Treatment

Event Six (9/28/2016)

<table>
<thead>
<tr>
<th>Influent</th>
<th>Effluent</th>
<th>Removal</th>
</tr>
</thead>
</table>

- **HLR** (gpm/(ft²) / SLR (lbs TSS/ft²-D))
- **TSS (mg/L)**
- **CBOD (mg/L)**
- **UVT (%)**
MSDGC Remote Site
CSO Treatment

Event Eleven (12/06/2016)

- **HLR (gpm/ft²)** / **SLR (lbs TSS/ft²-D)**
- **TSS (mg/L)**
- **CBOD (mg/L)**
- **UVT (%)**

Event Eleven (12/06/2019)

- **Influent**
- **Effluent**
- **Removal**

Graphs showing data for different parameters and removal percentages.
**MSDGC Remote Site**

**CSO Treatment**

![Graph showing Cloth Media Filter - Effluent versus Influent TSS](image)

- **Influent TSS (mg/L)**
- **CMF Effluent TSS (mg/L)**

- **Dates:**
  - 26-Sep
  - 28-Sep
  - 19-Oct
  - 6-Dec

*Providing Adaptive Water Management Solutions*
MSDGC Remote Site
CSO Treatment

TSS Removal - CMF Filter Pilot

- Influent TSS
- CMF Effluent TSS
- CMF TSS Removal

Providing Adaptive Water Management Solutions
MSDGC Remote Site
CSO Treatment

Cloth Media Filter - Removal versus Influent TSS

TSS Removal (%)

Influent TSS (mg/L)

- 26-Sep
- 28-Sep
- 19-Oct
- 6-Dec
Providing Adaptive Water Management Solutions
Large Installation Layout
Concrete Installation Layout

Providing Adaptive Water Management Solutions
Concrete Installation Layout

Providing Adaptive Water Management Solutions
Concrete Installation Layout

Providing Adaptive Water Management Solutions
OptiFiber® Pile Cloth Media
Frequently Asked Questions

• Automatic startup, instantaneous
• More space under the disks to allow for grit
• Extra depth at the top to allow for scum
• Scum removal trough
• Backwash sent to the wastewater plant
Summary
Summary

• Phosphorus removal is a plant wide process

• Filters remove particulate associated phosphorus.

• Cloth media filtration is well suited for low level phosphorus applications.

• Keep in mind basic concepts when looking at phosphorus removal
Questions