Wet Weather Impacts on Treatment Plants

AGENDA
Why?

Increasing Need for Wet Weather Resiliency

Magnitude → Higher
Frequency → Higher
Duration → Longer

The U.S. Just Had Its Wettest 12 Months on Record (Again)

Contiguous U.S. Precipitation, July-June

The last 12 months were the wettest July to June period by far in U.S. records dating back to 1895. The total of 57.86 inches is more than 3 inches more than the previous July-to-June record. The last 12 months are also the wettest of any year long span in U.S. records.
Impacts to Treatment

- Influent first-flush and dilution
- Headworks overloading
- Clarifier overloading
- Biomass washout
  - Critical piece of treatment process
  - Recovery can take weeks
  - Nitrifiers and fermenters most sensitive

Much different treatment challenges and environmental conditions than dry-weather.

Optimal results require different strategies and different design approaches.
How?

Complex Challenge Requires Holistic Approach

Main Goals

- Reduce risk from overflows
- Protect public health and water quality
- Sustainable and affordable
Valuable Guidance Recently Published

Deep Step-Feed to Optimize Biological Treatment

- Temporary change to contact stabilization mode for wet-weather flows
- “Biological contact” or “biocontact”
- Good for plug-flow basins
- Decrease clarifier solids loading rate (SLR) temporarily

Help maximize biological treatment of wet-weather flows
Biomass Transfer Accomplishes Same

- Transfer some RAS or MLSS to offline storage.
- Return biomass after storm flows pass.
- Good for complete-mix basins, oxidation ditches, etc.

Another way to reduce SLR to clarifiers ... temporarily

S2EBPR is New Reality for BNR

Conventional Enhanced Biological Phosphorus Removal (Bio-P or EBPR)

Great news for BNR
- More efficient use of influent carbon for TP and TN removal
- Less chemical usage (ferric, alum, methanol, etc.)
- Negligible EBPR impact from cold or wet-weather influent

S2EBPR + surface wasting → sludge densification (granulation)
More S2EBPR Proof from Eastern Kansas

**Cedar Creek WWTP (Olathe, Kansas)**
- 5.3-mgd ADF | 5-stage Bardenpho, ML Fermenter
- Unfavorable COD:P, no supplemental carbon
- Backup ferric not used, no filter
- Average effluent TP <0.5 mg/L, TN <6 mg/L
- Operating since Fall 2012

**Wakarusa WRF (Lawrence, Kansas)**
- 2.5-mgd ADF | 3-stage oxidation ditch with S2EBPR
- No filter, no chemicals
- Average TP <0.2 mg/L, NO$_3$-N <8 mg/L
- No upset during 3Q wet-weather event

**Wet-weather blending is not a bypass**

- NPDES bypass rule meant for petrochemical industry baseflow, **not** POTW peak flows
- If blending and meeting permit limits, don’t call it *bypass or diversion*
Not ye olde blending

Added value
- Significant additional infrastructure investment
- Auxiliary facilities increase resiliency and redundancy
- EHRT effluent quality equivalent to secondary effluent

If auxiliary treatment, don’t call it bypass or blending... especially if EHRT technology

After Optimizing Existing Facilities, Consider Auxiliary Peak Flow Capacity

- Complement inherent limitations of biological processes
- Optimized for intermittent wet-weather flows
- Long track record of success
- Better resiliency to wet weather events

"Core" Process for Auxiliary Facilities
## Clarification Alternatives

<table>
<thead>
<tr>
<th>Settling-Based</th>
<th>Filtration-Based</th>
<th>Flotation-Based</th>
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<tbody>
<tr>
<td>1. Conventional Setting - Rectangular, Circular, Square RTB, Shaft</td>
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<tr>
<td>2. Vortex (Swirl Concentrator)</td>
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<td>3. Lamella Settler</td>
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<tr>
<td>4. Chemically Enhanced SETTling</td>
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<tr>
<td>a. Conventional Basin</td>
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<tr>
<td>b. Sequencing Batch - e.g. ClearCove Flatline EPT</td>
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<td></td>
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<tr>
<td>c. Lamella Settler</td>
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<tr>
<td>d. Solids Contact / Recirculation - e.g. DensaDeg®, CONTRAFAST®</td>
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<tr>
<td>e. Ballasted Flocculation - Microsand (e.g. ACTIFLO®, RapidSand™, Denisaging WAC™) - Magnetite (e.g. CoMag™)</td>
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<tr>
<td>5. Suspended Growth Contact - BIOACTIFLO™, BioMag™, Bio-CES</td>
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<td></td>
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<tr>
<td>1. Shallow Granular Media</td>
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<td></td>
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<tr>
<td>2. Deep Granular Media</td>
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<td></td>
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<tr>
<td>3. Microscreens, Woven Media - Salsnes Filter, Eco MAT® Filter, Hydrotech Discfilter, SuperDisc™, Forty-X™ Disc, Quantum™ Disk</td>
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<tr>
<td>4. Floating Media - MetaWater High Speed Filter, BKT BBF-F</td>
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<td></td>
</tr>
<tr>
<td>2. Dissolved Air Flotation (DAF) - Various suppliers</td>
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<td></td>
</tr>
<tr>
<td>3. Polymeric-aided DAF - Various suppliers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Biocontact + DAF - Captivator®</td>
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</tbody>
</table>

| Primary Removal Equivalent * | High-Rate Treatment (HRT) | Enhanced HRT |

* If coagulation/flocculation provided, HRT → EHRT (in some cases)

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### Why EHRT?

- **Better disinfection**
  - Removes colloidal TSS, turbidity and associated organics and other pollutants
  - ~50% less disinfectant dose
- **Equivalent to secondary effluent quality**
- **Considered “Non-biological peak flow secondary treatment processes” by 8th Circuit Court (Iowa League of Cities v. EPA)**
- **Some regulators consider EHRT to be best available technology economically achievable (BAT)**

Minimize public health risk. Small footprint. Cost effective
Some high-rate filters (HRF) offer same TSS removal as HRC...

...typically without chemicals

Other HRF Technologies Emerging for Wet Weather

Compressible Media  Pile Cloth Media  Silicon Carbide Ceramic Membrane

- Requires coagulant dosing
- Ovivo/B&V pilot in Austin, TX for reuse/Title 22
- CSO pilot in King County, WA

No full-scale wet-weather applications to date
Dual-Use Auxiliary Facilities

- Improve Effluent Quality
- OR
- Improve Energy Efficiency

More treatment benefit from capital investment than just infrequent wet weather

Applied Research & Development of HRF

- 2009
  HRT Pilots
  St. Joseph, MO

- 2008
  HRF Pilots
  Nelson Complex
  Johnson County, KS

- 2010 – 2011
  CMF Pilot
  Springfield, OH

- 2014
  CMF Pilot
  Springfield, MO

- 2016
  HRF Pilots
  Little Rock, AR

- 2002
  HRT Pilots
  King County, WA

- 2008
  HRF Pilot
  Nelson Complex
  Johnson County, KS

- 1990's
  Advanced Demonstration Facility
  Columbus, GA

- 2010 – 2011
  CMF Pilot
  Springfield, OH
Examples

Compressible Media Filter from Concept to 100-mgd Reality

- Eliminated CSO-related bypasses at WWTP
- $33.5M (2011; Springfield, OH) → $0.34/gpd
- 320 ft x 120 ft footprint
- No added staff, SCADA-controlled operation
- Tertiary dual-use for future TP limits

Cost-effective CSO treatment and disinfection

<table>
<thead>
<tr>
<th>Effluent Averages *</th>
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<tbody>
<tr>
<td>TSS mg/L</td>
<td>14</td>
</tr>
<tr>
<td>CBOD₅ mg/L</td>
<td>20</td>
</tr>
<tr>
<td>NH₃-N mg/L</td>
<td>2.3</td>
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<tr>
<td>TP mg/L</td>
<td>0.4</td>
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<tr>
<td>DO mg/L</td>
<td>8.7</td>
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<tr>
<td>TRC mg/L</td>
<td>0.02</td>
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<tr>
<td>E. Coli #/100 mL</td>
<td>56</td>
</tr>
</tbody>
</table>

* 63 events Mar 2015 – May 2017
** NaOCl dose < 4 mg/L (avg)
Advances in Pile Cloth Media Filter

- Larger disk and unit capacity
  - 10 to 24 mgd per cell, depends on TSS loading
  - Similar footprint as ballasted flocculation
- Deeper basin for better solids handling
  - Heavy solids drop to grit/sludge hoppers
  - Floatables stay above filter
  - Filters in optimal zone for small particles
- 5-micron polyester microfiber media
  - Effluent equivalent to compressible media
  - Better wear than previous generation nylon

Adapted for primary and auxiliary wet-weather applications

Reference Pile Cloth Applications

- Widespread use in tertiary applications
  - Same mechanical design and equipment as primary/CSO/SSO applications
- Wet-weather and primary applications:

<table>
<thead>
<tr>
<th>Location</th>
<th>Application</th>
<th>Peak Flow (mgd)</th>
<th>Startup</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fox Metro, IL</td>
<td>Tertiary/CSO</td>
<td>168</td>
<td>2012</td>
</tr>
<tr>
<td>Wood Dale, IL</td>
<td>Tertiary/SSO</td>
<td>14</td>
<td>2014</td>
</tr>
<tr>
<td>Linda County, CA</td>
<td>Primary Influent</td>
<td>2.5</td>
<td>July 2017</td>
</tr>
<tr>
<td>Rushville, IN</td>
<td>Tertiary/CSO</td>
<td>12.6</td>
<td>Aug 2017</td>
</tr>
<tr>
<td>Youngstown, OH</td>
<td>CSO</td>
<td>40</td>
<td>Jun 2019</td>
</tr>
<tr>
<td>Oak Hill, WV</td>
<td>Primary Influent</td>
<td>2.6</td>
<td>Aug 2019</td>
</tr>
<tr>
<td>Sand Island, HI</td>
<td>Primary Effluent</td>
<td>1</td>
<td>Oct 2019</td>
</tr>
<tr>
<td>Little Rock, AR</td>
<td>Tertiary/SSO</td>
<td>58</td>
<td>Jun 2020</td>
</tr>
<tr>
<td>Johnson County, KS</td>
<td>Tertiary/SSO</td>
<td>115</td>
<td>2021</td>
</tr>
<tr>
<td>Morro Bay, CA</td>
<td>SSO</td>
<td>6.3</td>
<td>2021</td>
</tr>
</tbody>
</table>
Case Study - Little Rock, Arkansas

- Parallel EHRT favored over pre-2013 plan for EQ basin expansion:
  - More resilient, not limited by finite volume
  - Much smaller site, no additional odor control
  - Lower life-cycle cost
- 2015 – NPDES permit by ADEQ, no EPA comments
- 2016 – TBL evaluation, onsite pilot, reference facility tours. Pile cloth filter recommended:
  - Simple O&M
  - No chemicals
  - No alkalinity or effluent foaming issues
  - Improve existing UV disinfection performance
  - Support effluent reuse
  - Lowest life-cycle cost

Dual-Use EHRT
(A) Treat wet-weather flows ~5% of time
(B) Improve disinfection 100% of time

New pile cloth media performed better than previous generation media in 2008 side-by-side trials in Johnson County, Kansas
Dual-Use EHRT Under Construction

Four bids on 100% design

- $23.9MM for 58-mgd EHRT → $0.41/gpd (2018; Little Rock, AR)
  - Dual-Use Filter, UV, Effluent Pump Station
- 2020 startup

Case Study – Johnson County, Kansas

Outside 8th Circuit of U.S. Court of Appeals
Enhanced P Removal and Wet-Weather Treatment

Tomahawk Creek WWTF

- SSO control outside 8th Circuit
- Expand 7-mgd WWTP to 19-mgd ADF and upgrade to TP<0.5 mg/L, TN<10 mg/L
- 115-mgd HRF + Disinfection = $23MM $0.20/gpd (2018; Johnson County, KS)

Tomahawk Creek WWTF Filter Facility Plan View

- Filter Effluent Channel
- Filter Influent Channel
- Peak Wet-Weather Screened Influent Up to 115 mgd (435 ML/d)
- BNR Effluent Up to 57 mgd (216 ML/d)
- Pile Cloth Filter Cell (Typical of 8)
- Backwash and Solids Pump Room (Typical of 4)

Very Small Footprint

190 ft (58 m)
60 ft
18.3 m
Tomahawk Creek WWTF Filter Facility Section Views

Pile Cloth Filter Cell  
(Typical of 8)

Backwash and Solids Pump Room  
(Typical of 4)

Tomahawk Creek WWTF Construction

CMAR design-build on track for 2021 startup
Words Really Matter For Peak Flow Management Success

<table>
<thead>
<tr>
<th>Instead of:</th>
<th>Consider:</th>
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<tbody>
<tr>
<td>Divert</td>
<td>Intercept or regulate</td>
</tr>
<tr>
<td>Diversion Structure</td>
<td>Interceptor or regulator structure</td>
</tr>
<tr>
<td>Bypass</td>
<td>Flow split, control or regulate</td>
</tr>
<tr>
<td>Excess flow</td>
<td>Peak flow</td>
</tr>
<tr>
<td>Blending</td>
<td>Peak flow management</td>
</tr>
<tr>
<td>Primary treatment</td>
<td>Settling</td>
</tr>
<tr>
<td>Secondary treatment</td>
<td>Biological treatment</td>
</tr>
<tr>
<td></td>
<td>Activated sludge</td>
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<tr>
<td></td>
<td>Trickling filter</td>
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If treating adequately, don’t imply lack of treatment. Use scientifically accurate language to describe design and operation. Avoid connotations and misinterpretations.
THANK YOU!!

Tomahawk Creek WWTF

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