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# Troubleshooting Activated Sludge: Identifying and Mitigating Impacts of Drought Conditions

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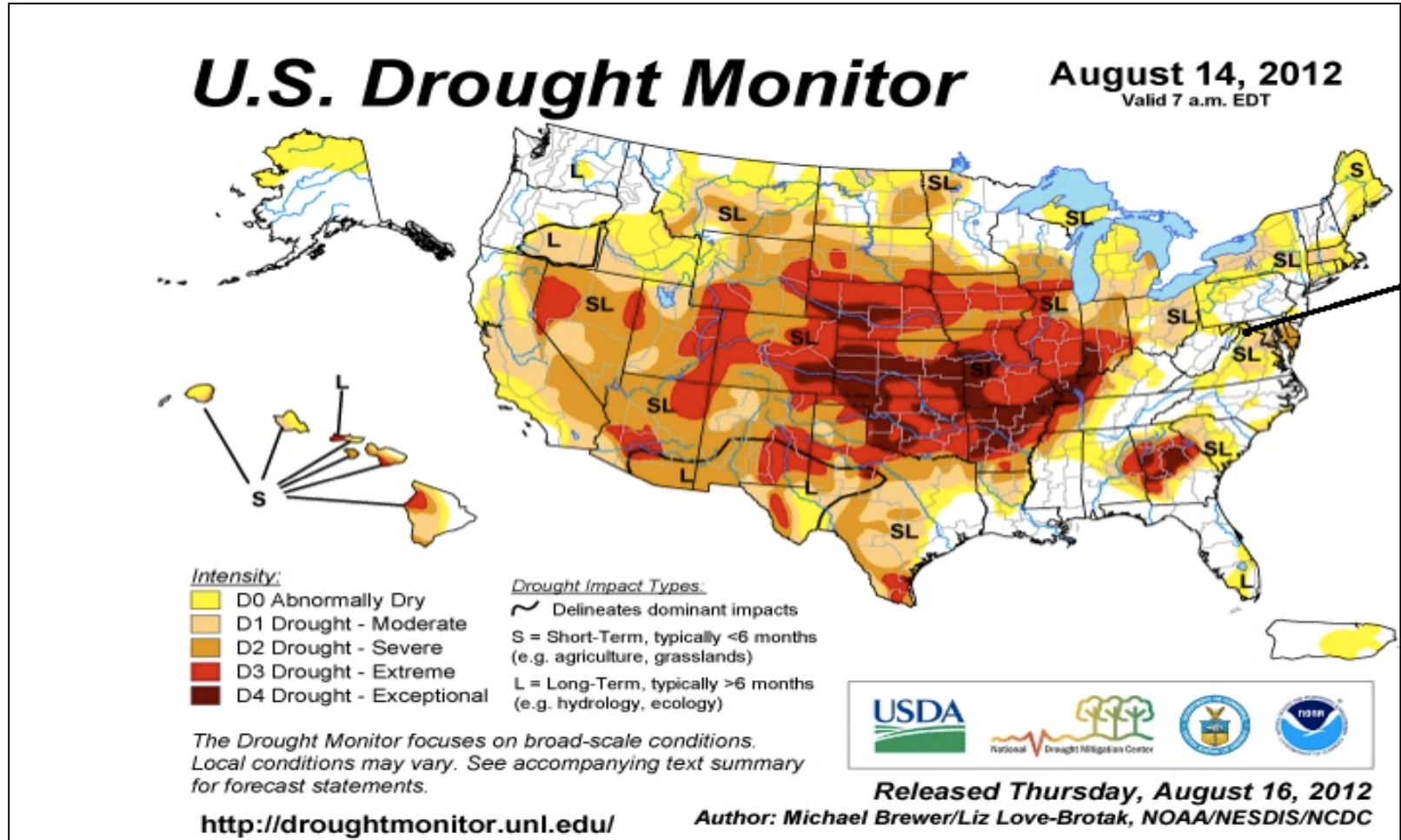
# Outline of Presentation

- Background
- Identifying Treatment Stresses: Background
- Proactive Observations
- Underlying Triggers
- Mitigating Actions
- Case Studies

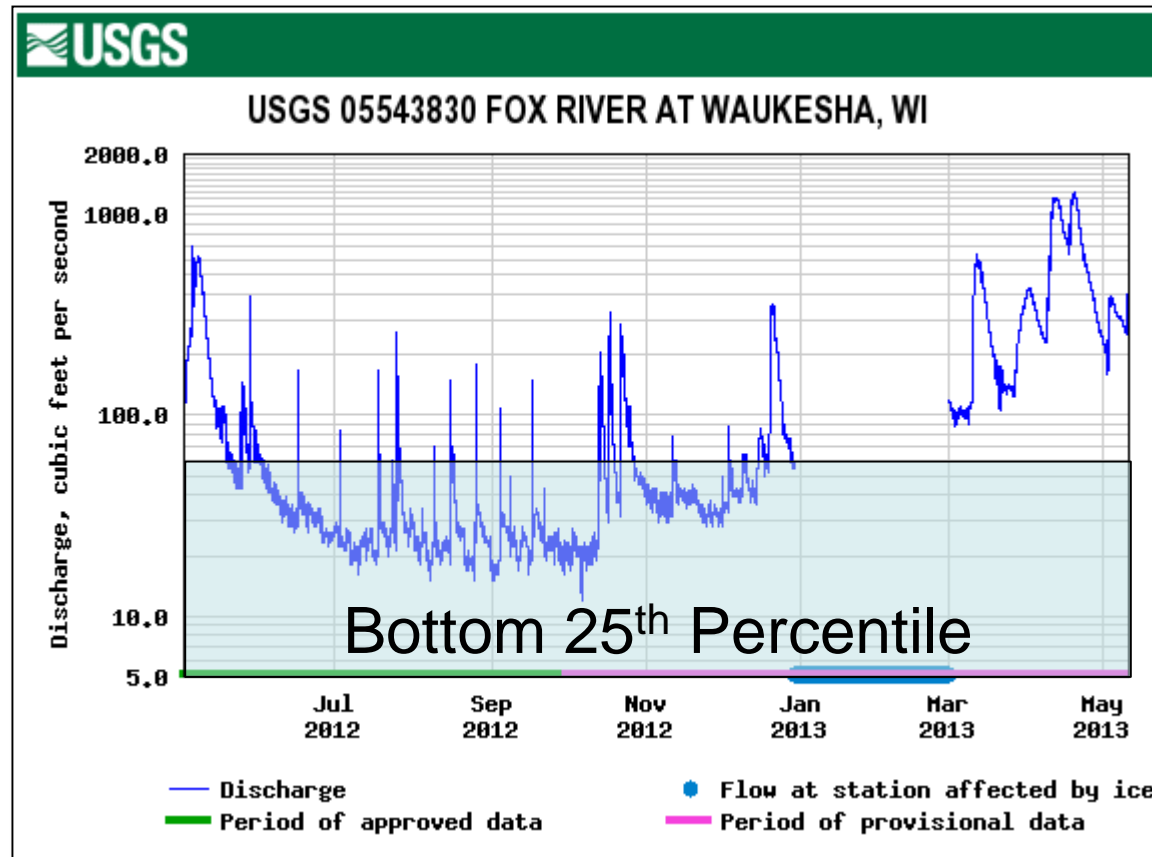
# Background



# 2012 Produced Drought Conditions Through Much of the Midwest



# Drought Conditions Reduced River Levels and the Potential for Inflow and Infiltration along with the Associated Dilution



Low River Flows Typical in Impacted Areas

# Drought Conditions Selected Undesirable Conditions in Our Yards...



...unless you like dandelions.

# Drought Conditions Selected Undesirable Conditions in Our Activated Sludge Systems

- Visual Observations
  - Rapid Setting Sludge
    - Poor Flocculation
  - Murky Supernatant in Settling Test
  - Murky (pea green) Appearance at Clarifiers
  - Increase in Effluent Suspended Solids





# Identifying Treatment Stresses: Background

# Stable Conditions are Required for Proper Floc Formation

- “The following factors can adversely affect floc formation:
  - Sludge Age\*
  - Slug Discharges
  - Toxicity
  - Surfactants
  - Excessive Shearing\*\*”
- Toni Glymph, *Wastewater Microbiology: A Handbook for Operators*

**\* Ruled out as early steps in troubleshooting process, not a significant part of this presentation.**

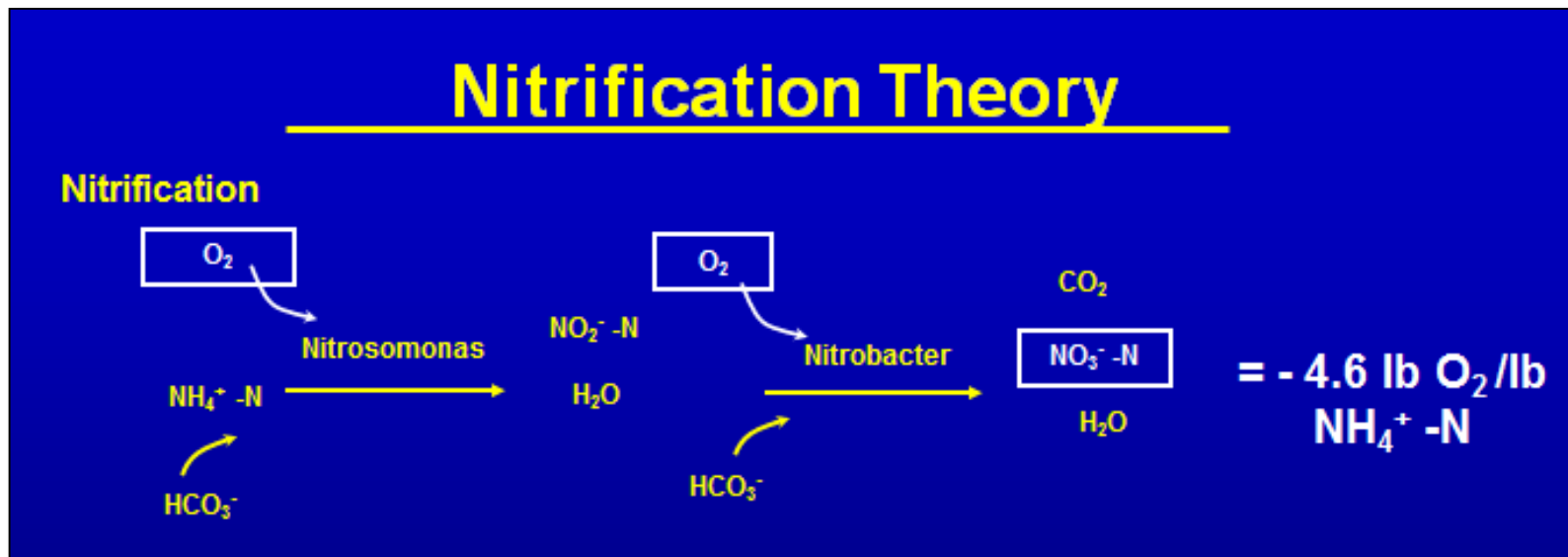
# Description of Treatment Stress

- Potential Analytical Observations
  - Influent
    - Temperature Increase
    - Soluble Fraction Increases
    - Sulfides
    - pH Changes
  - Effluent
    - TSS Spike
    - BOD Spike
    - Ammonia Spike
    - Nitrite (NO<sub>2</sub>) Spike



# Description of Treatment Stress

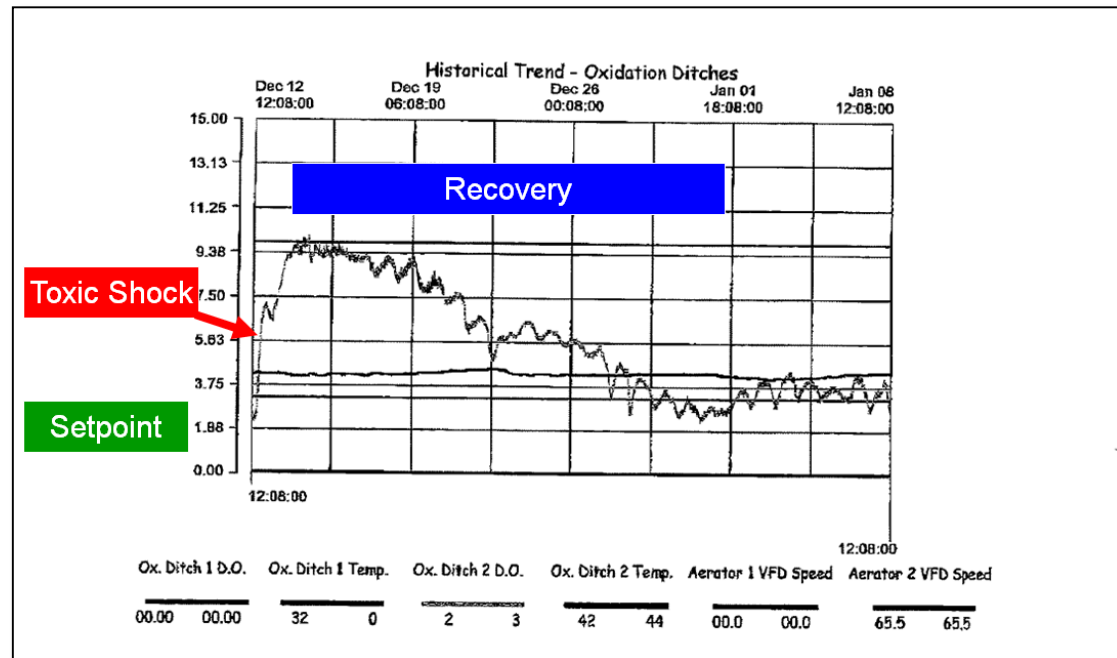
- Nitrification stress might be defined as:
  - Effluent ammonia concentrations are not as low as typical or expected
  - Nitrite is present in effluent when not typical



- 12.9 lbs of  $\text{Cl}_2$  consumed per mg/L  $\text{NO}_2^-$  per MGD

# Description of Treatment Stress

- Process Observations
  - Automation Changes
    - Less Air Required
    - More Air Required
    - Lower Residuals Detected; More Chlorine Required
    - Oddities in Optical Measurements

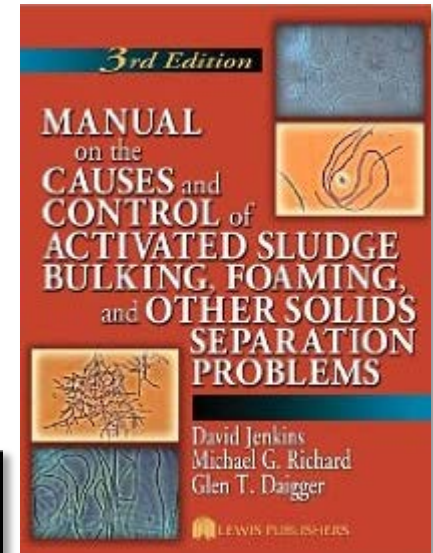
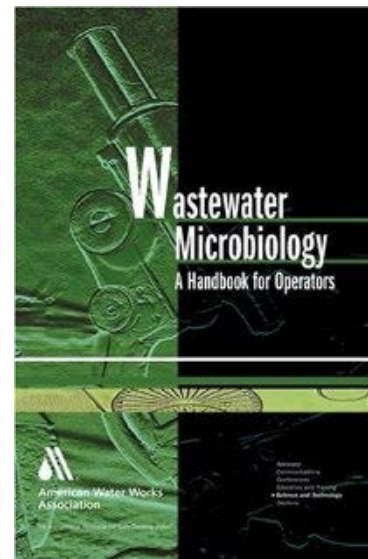


# Proactive Observations

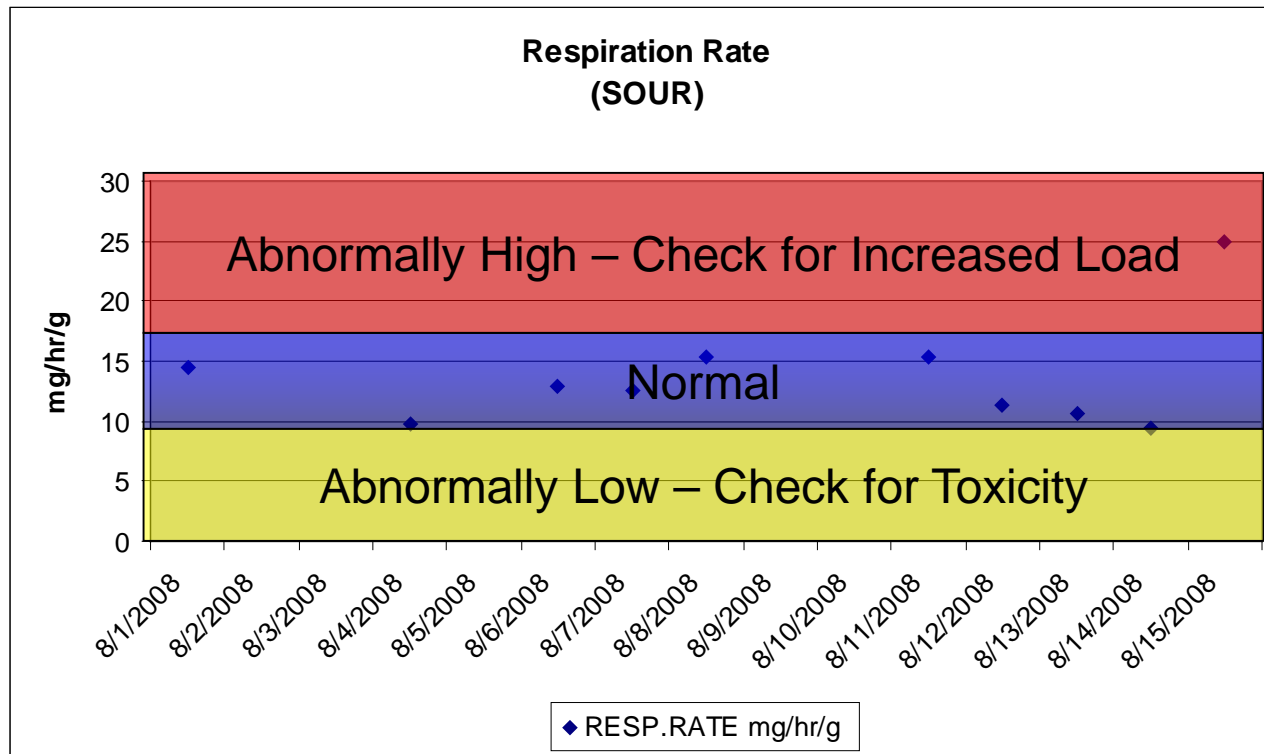


# Microscopy Can Indicate if Toxicity may be a Factor

- Microscopy Evaluations
  - Changes in indicator organisms
    - More Flagellates
    - More amoeba
    - Testate or shelled indicator organisms
    - Fewer higher life forms or inactive higher life forms
    - Stress to filamentous bacteria
    - Stress to floc formation
  - Get trusted sources for reference
  - Do in-house and do so consistently



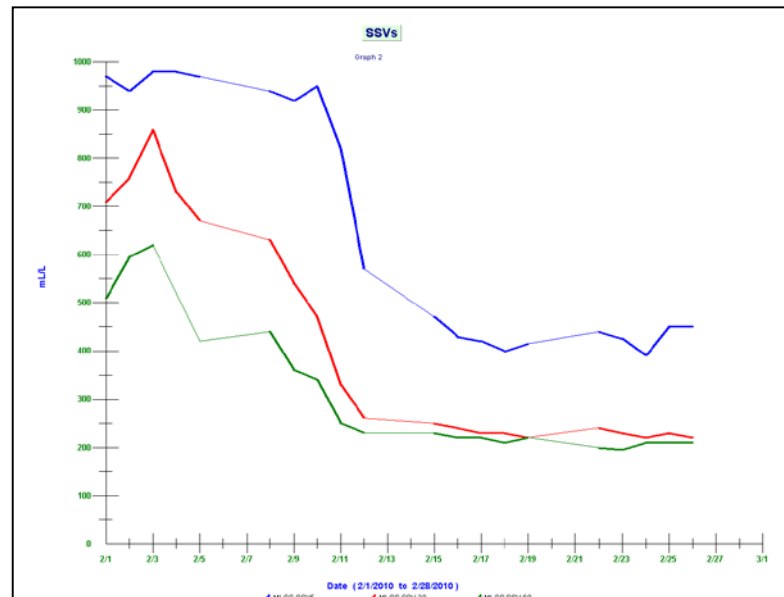
# Regular SOUR or OUR Analysis May Identify Meaningful Changes in Characteristics



# Trends of Key Information Such as Settling Characteristics Provides Timely Information

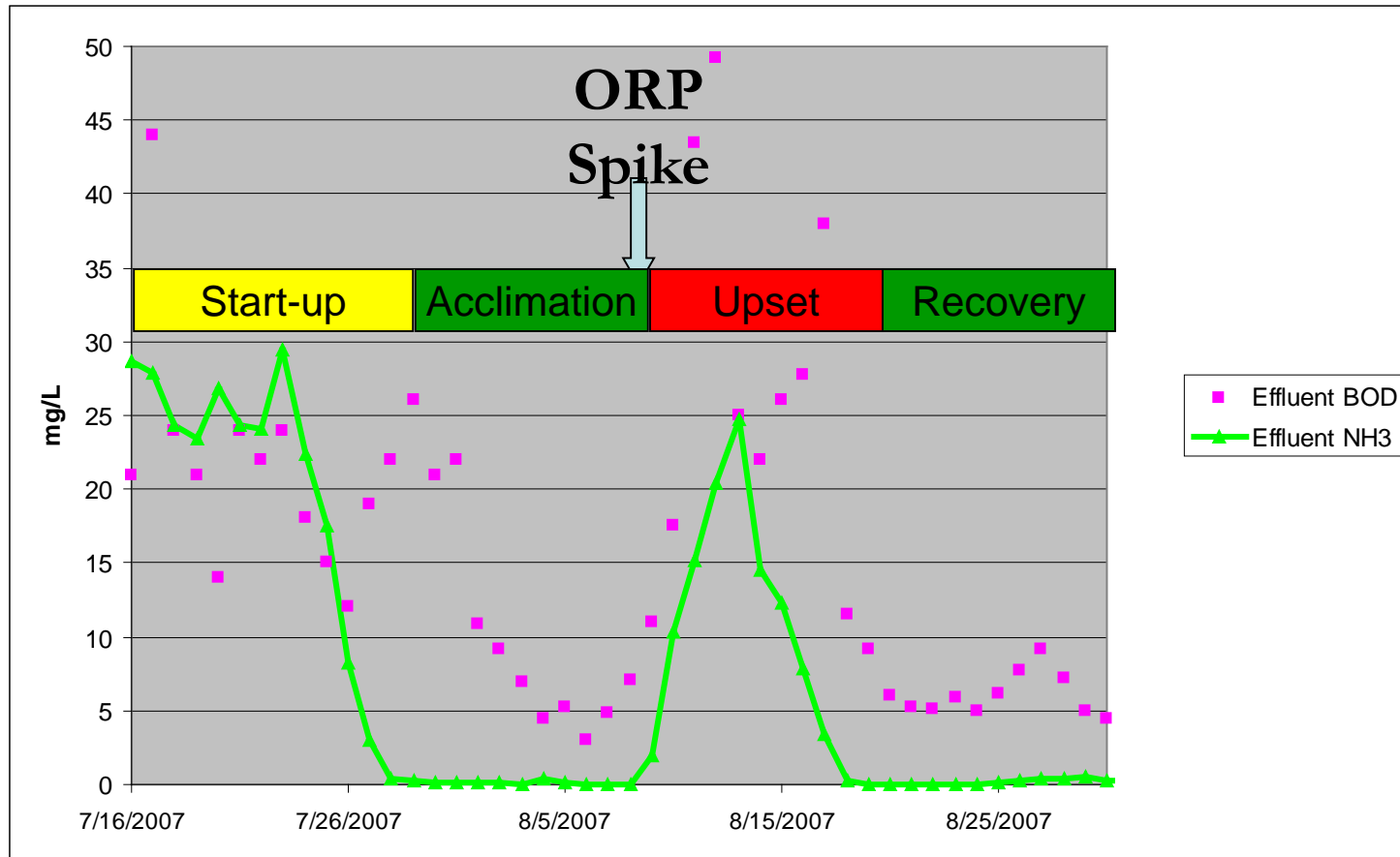
|          |                   |                   |                 |                |                      |                  |             |             |
|----------|-------------------|-------------------|-----------------|----------------|----------------------|------------------|-------------|-------------|
| Effluent | BOD Load          | COD Load          | pH              | WASq v Eff TSS | Res. Rate v Effl TSS | Tanks in Service | Res vs Load | SVI vs MLSS |
| Flow     | COD Concentration | BOD Concentration | Primary Removal | RAS            | Nitrogen v Effluent  | SSVs             | Sludge Age  | WAS lbs     |

Database shortcuts to meaningful trends



Trend of Settling Characteristics

# In Situ Instruments Can Assist In Identifying Unwanted Changes In Influent Characteristics



# Underlying Triggers



# Underlying Triggers

- Loss of Dilution
  - Chemicals
  - Metals
  - Organic Loads
- Change in Hydraulic Detention Times
  - Sewer
  - Process Tanks
- Change in Temperature
  - Less volume, more time, warm ambient conditions = Warm Activated Sludge

The gradual changes associated with droughts makes identification of stresses difficult.

# Chemicals of Interest Include:

- Quaternary Amines
  - Used in cleaning chemicals
  - Accumulate through adsorption
  - Degrade slowly
- Anionic Surfactants
  - Used in cleaning chemicals
  - Coats bacteria surface causing deflocculation
  - Foam may be associated with these wastewaters

If your industries use a chemical to kill bacteria at their facility, they should understand what it does at yours.

# Wastewater Characteristic Changes of Interest Include:

- Volatile Fatty Acid Formation
  - Can impact floc characteristics
  - May be indication of increase in anaerobic environments
  - May promote filamentous growth
- Sulfide Toxicity
  - Very pH Dependant
  - May indicate new or greater sources of H<sub>2</sub>S

“ Sulfide toxicity to activated sludge is more common than currently recognized.” Michael Richard Ph.D. *Activated Sludge Microbiology Problems and Their Controls*

@ a pH of 7.0 s.u., 1 mg/L H<sub>2</sub>S decreased oxygen uptake by 50 %  
@ a pH of 8.0, 100 mg/L H<sub>2</sub>S was required to get the same response



## Mitigating Actions

**Anecdotal Feedback and Experience From Multiple Facilities**

# Wasting Rates

- Sludge Ages that had been traditionally successful may be too old for current (drought/low flow) conditions.
  - This may indicate that issues were centered around bio accumulative stresses such as metals or persistent biocides/cleaning chemicals.
- Subtle increases in wasting seemed to help although sludge ages did not appear to be the trigger.

# Dissolved Oxygen

- Aerobic processes that are being stressed typically benefit from generous dissolved oxygen targets.
- Facilities without DO automation appeared to suffer when they had not in the past.
- One facility may have had lower oxygen consumption because of loss of nitrification, the automation may have lowered the air flow to a point that dead zones were created.
  - Control adjustments protected against future occurrences.



# Polymer Addition

- Polymer can be used to improve floc formation.
- Lab results frequently out perform temporary set-ups because:
  - Lack of flow pacing
  - Limitations at application point
- Tips for improving polymer application
  - Work with supplier
  - Set temporary pacing
  - Add to well mixed area
  - Monitor floc at clarifier stilling well
  - Add in conjunction with coagulant as necessary

# Industrial Pretreatment

- Communicate with pretreatment coordinator – In House
- Gain political will if necessary
  - Respectfully proceed
- Discuss Cause and Effect Relationships with Industry
  - Raw Materials
  - Cleaning Chemicals
  - By-Products
  - Products

## Identify Potential Causes

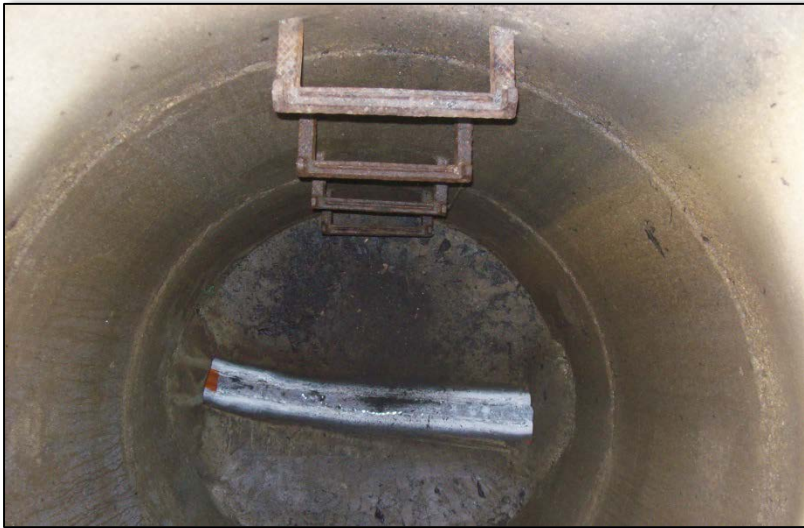
- Cleaners
- Disinfectants
- Biocides
- Concentrated Products
- Surfactants
- Emulsifiers
- Acids/Bases
- Boiler Treatments

What is xanthan gum?

# Case Studies



# Case Study - Small Facility with Rapid Change in Settling and Murky Effluent

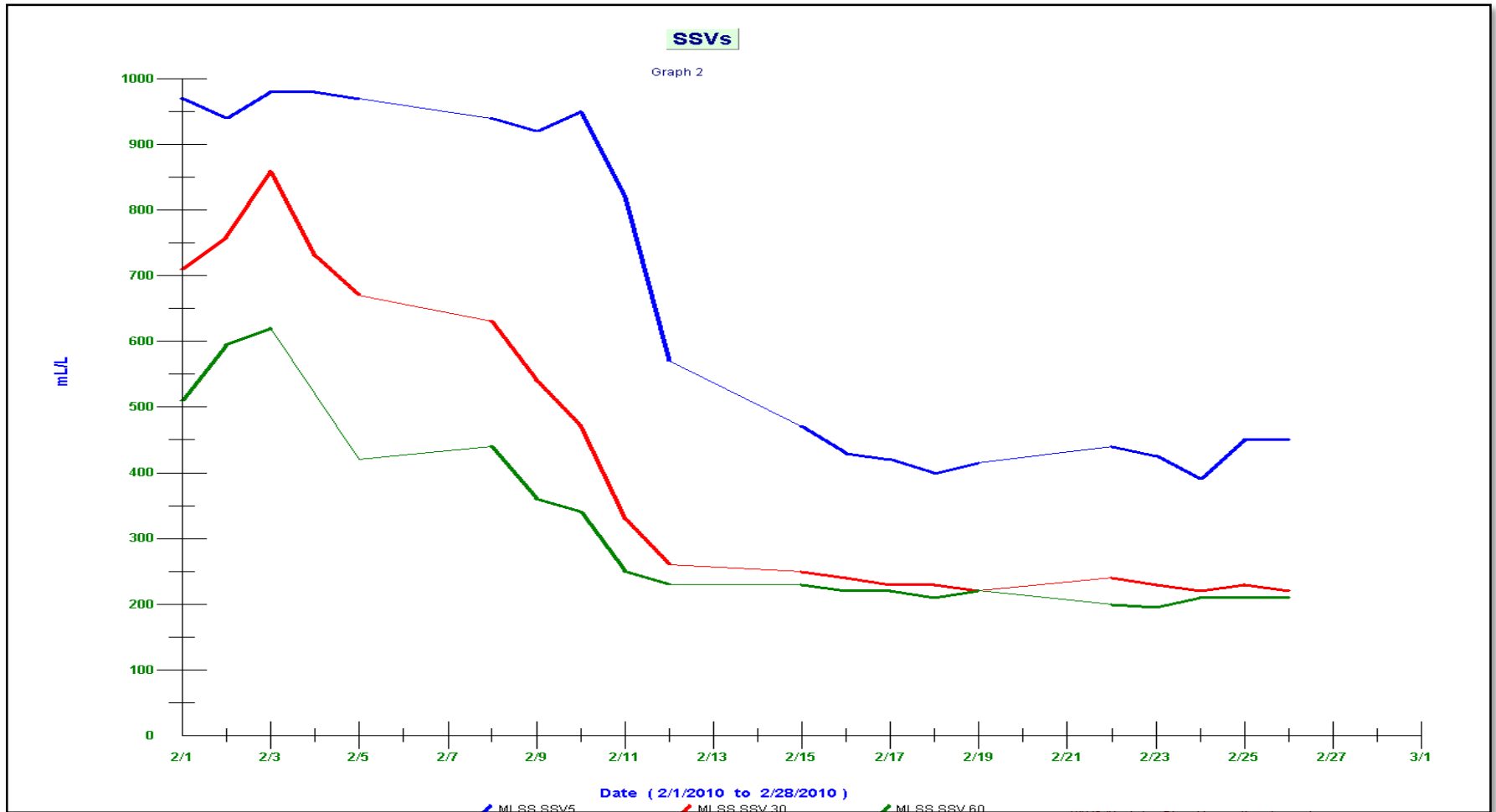


- Community of 1400
- Flow of ~ 60,000/day
- 43 gpd per person
- Treatment stress identified
- Collected samples, opened manholes
- Found paint being dumped

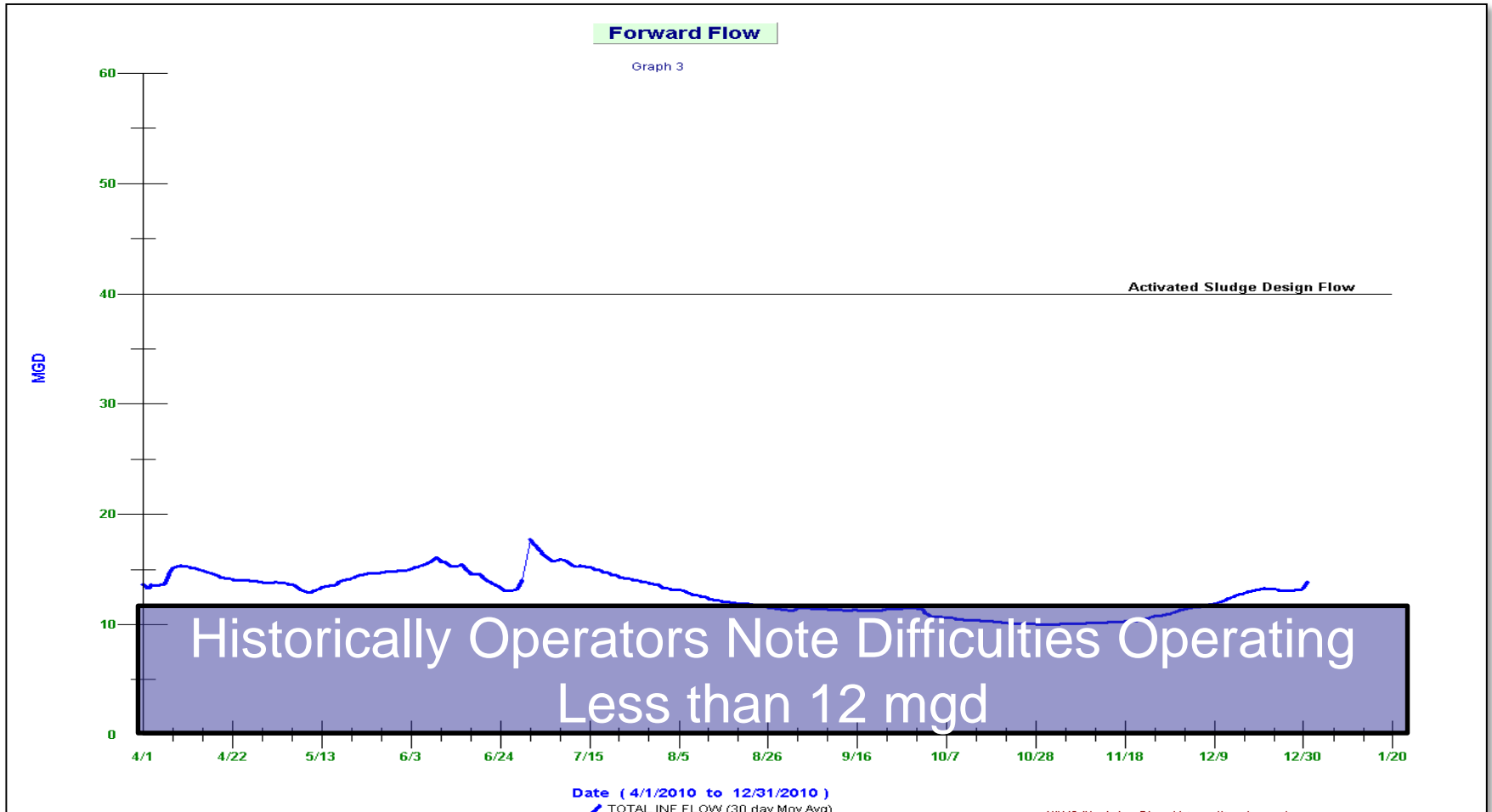
# Case Study – 20 mgd Facility with Murky Effluent at Low Flows

- Quick changes in settling characteristics blamed on DO control
  - Addition of DO control greatly reduced occurrence, but did not eliminate
- Significant industrial base
- SCADA included pH at influent to indicated significant changes
- Operators suspected industrial influence; a data review was requested
  - Following review of the data a meeting was set with one industry and favorable results were achieved

# Rapid Change in Settling Characteristics Had Become a Precursor to Poor Treatment

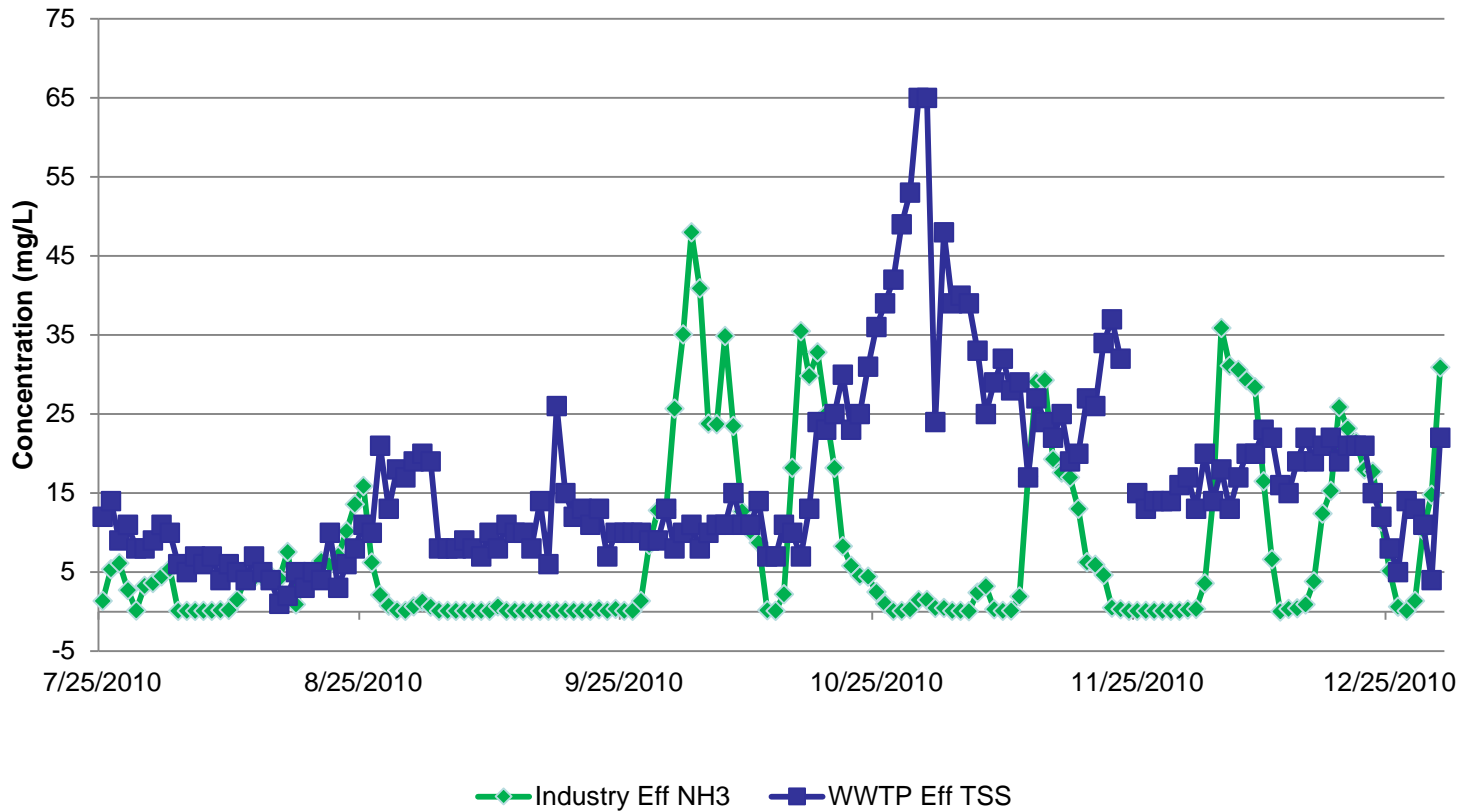


# Industrial Activities Have Been More Impactful During Lower Flow Conditions



# Industrial Ammonia Discharges Determined to Be Amines Linked to WWTP Treatment Stress

## 2010 WWTP TSS vs Industry Ammonia (or Amines)



# Closing Thoughts



# Additional Closing Thoughts

- Improvements to cleaning chemicals, biocides, and other important products may have a negative impact on wastewater treatment
- Drought conditions may allow hidden stresses to reveal themselves
- Monitoring and proactive responses can improve performance
- Industrial pretreatment may be improved through simple communications



# Questions and Answers



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