Critical Mass - Operating at Less Than Firm Capacity and Pushing Processes to Their Limit

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Agenda

• Introduction
• Background
• Failure
• Pushing the limit
• Model Comparison
• Lessons Learned
• Conclusion
Background

• NPDES Rated at 30.6 MGD
• 2 interconnected facilities about 1 mile apart
Clinton River WRFF – East Boulevard and Auburn Sites

East Boulevard

Silverdome

Auburn
East Boulevard Site Layout

- Retention Basin
- Headworks
- Primary Clarifiers
- Final Clarifiers
- Aeration Basin
Auburn Site Layout

- Headworks
- Primary Clarifiers
- Digesters
- Aeration Basin
- Secondary Clarifiers
- Tertiary Filtration
- Disinfection
- Clinton River
Failure

- 3 Aeration Tanks ‘floated’ from hydrostatic pressure
Failure – July 2017

Approximately 30% capacity available
Failure – September 2017

Approximately 60% capacity available
Failure – May 2018

Approximately 85% capacity available
Failure – July 2018

100% capacity available
## Pushing the Limit

<table>
<thead>
<tr>
<th></th>
<th>Prior to Failure (Jan-May)</th>
<th>Post Failure 2 Tanks (Sept-Nov)</th>
</tr>
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<tbody>
<tr>
<td>Influent Flow</td>
<td>13.45 MGD</td>
<td>10.54 MGD</td>
</tr>
<tr>
<td>Aeration Tank flow</td>
<td>17.21 MGD</td>
<td>11.74 MGD</td>
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<td>Aeration Tank flow/tank (avg)</td>
<td>4.3 MGD</td>
<td>5.87 MGD</td>
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Pushing the Limit

Detention Time

Fecal Coliform mg/l

Effluent Fecal Coliform
AB Influent
Pushing the Limit

Effluent Fecal Coliform

- Effluent Fecal Coliform
- AB Influent
- Perry St Flow
Pushing the Limit

Effluent Fecal Coliform

- mg/l
- mg/g

Hypo gal/MG

Graph showing the fluctuation of Effluent Fecal Coliform over the period from 9/1/2017 to 11/30/2017.
So What Happened?

- A Perfect Storm
BOD Analysis

Aeration Tank 1 placed online
Detention Time

Aeration Tank 1 placed online
Temperature

Aeration Tank 1 placed online
Pushing the Limit

Effluent Fecal Coliform

Aeration Tank 1 placed online

Fecal Coliform mg/l


Ammonia mg/l


Ammonia

Effluent Fecal Coliform
Nitrification-Denitrification Cycle

Nitrocellulose

Nitrobacter

Nitrosomonas

Aerobic

25% O₂

1 mole Nitrate
(NO₃⁻)

40% Carbon

Anoxic

75% O₂

1 mole Nitrite
(NO₂⁻)

60% Carbon

1 mole Ammonia
(NH₃ / NH₄⁺)

Nitrification / Denitrification

1/2 mole Nitrogen gas
(N₂)
Nitrification-Denitrification Cycle

*Nitrification occurs after BOD removal

BOD Removal Occurs First!!
Nitrification-Denitrification Cycle

“The conversion from ammonia to nitrite involves a complex series of reactions that control the overall conversion process as evidenced by the lack of nitrite buildup in the system”

-Metcalf and Eddy Wastewater Engineering
Nitrification-Denitrification Cycle

“The conversion from ammonia to nitrite involves a complex series of reactions that control the overall conversion process as evidenced by the lack of nitrite buildup in the system”
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Nitrification-Denitrification Cycle

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-Metcalf and Eddy *Wastewater Engineering*

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Bacteria General Trends

![Graph showing the relationship between Bacteria Growth and Retention Time with a positive correlation.](image-url)
Bacteria General Trends

1. Bacteria Growth vs. Retention Time
2. Bacteria Growth vs. DO
Bacteria General Trends

- Retention Time vs. Bacteria Growth
- DO vs. Bacteria Growth
- Temperature vs. Bacteria Growth
Nitrite and Disinfection

• Nitrite is a Chlorine Sponge

• Chlorine reacts with Nitrite Instead of Disinfecting

• Can’t Meet Fecal Coliform Limits Even with Increased Chlorine Dosage

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<th>Ammonia Demand:</th>
<th>Nitrite Demand:</th>
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<tr>
<td>1 mg/l Ammonia reacts with 10 mg/l chlorine</td>
<td>1 mg/l nitrite reacts with 5 mg/l chlorine</td>
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Model Analysis

- Ran a calibrated Biowin model
- Predicted 7.5 MGD influent flow in winter conditions
Lessons Learned

• Check for nitrites
• BOD is critical
• Slow Fade to the Tipping Point
• Model prior to pushing the limits
• Dry weather flow is different than Wet weather
Questions?

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