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- **Audio Modes**
  - Listen using Mic & Speakers
  - Or, select "Use Telephone" and dial the conference (please remember long distance phone charges apply).
- **Submit your questions using the Questions pane.**
- **A recording will be available for replay shortly after this webcast.**

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# FOOD FOR THOUGHT

## Using "True" F:M To Optimize Biological Treatment

Presented by:  
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LuminUltra Technologies Ltd.– Director of Product Applications

**Jesse Forth**  
SUEZ WTS – Sievers\* InnovOx Global Product Manager



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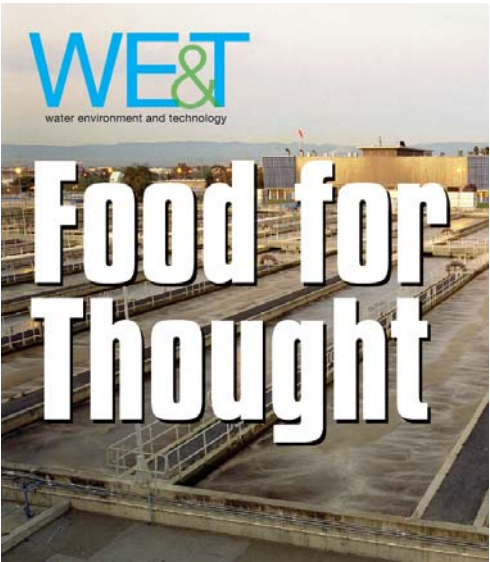
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## Food For Thought

### Overview

1. What Is F:M And How Is It Used?
2. Conventional Methods For F:M Determination
  1. MLSS/MLVSS
  2. BOD/COD
3. The "True F:M" Advantage
  1. Cellular ATP (cATP)
  2. Total Organic Carbon (TOC)
4. Case Study - "True F:M" In Practice
 

This southern US facility made the transition to using "True F:M" gaining control and achieving the optimal operating range of their biological treatment system.
5. Summary



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### What Is F:M?

Picture a hip new food craze...



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### What Is F:M?

Picture a hip new food craze...



Food

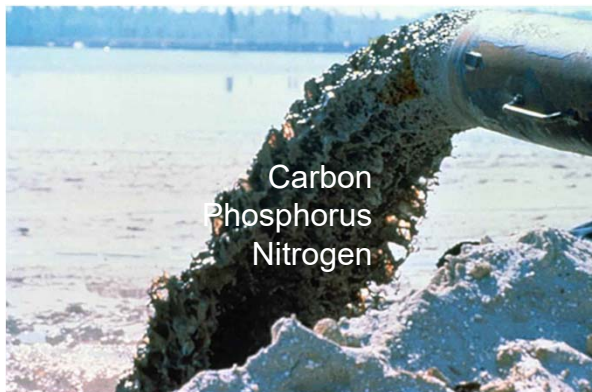


Microorganisms

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### What Is F:M?

Picture a hip new food craze...



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Microorganisms

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### What Is F:M?

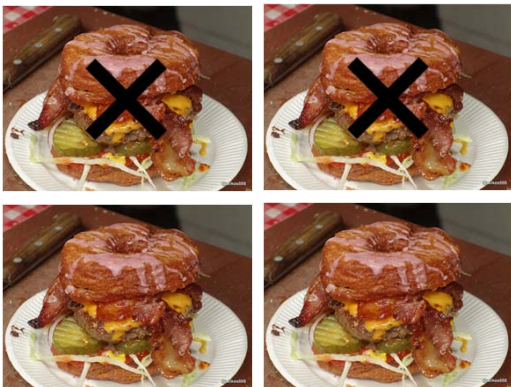
Picture a hip new food craze...



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### What Is F:M?

Picture a hip new food craze...



Food > Microorganisms

Food leftover (i.e. Poor treatment)

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### What Is F:M?

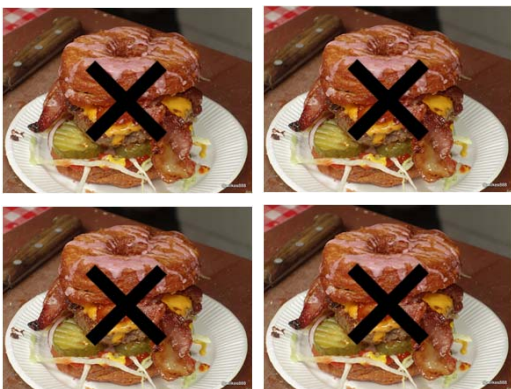
Picture a hip new food craze...



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### What Is F:M?

Picture a hip new food craze...



Food=Microorganisms

No food leftover (i.e. Optimal treatment)

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### What Is F:M?

Picture a hip new food craze...



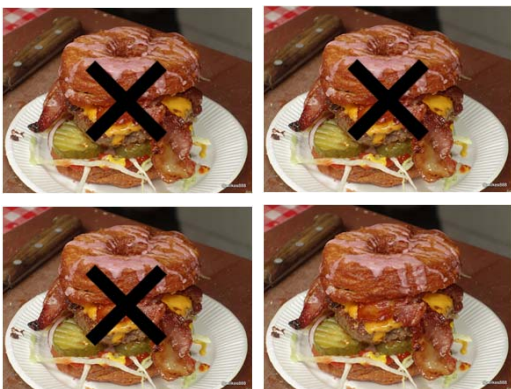
Food < Microorganisms

Microorganisms stop focusing on eating food and start fighting with each other  
Result: All the food doesn't get eaten (i.e. poor treatment)

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### What Is F:M?

Picture a hip new food craze...



Food < Microorganisms

Microorganisms stop focusing on eating food and start fighting with each other  
Result: All the food doesn't get eaten (i.e. poor treatment)

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## What Is F:M?

How does a wastewater treatment plant measure microorganisms?

Traditionally biomass is assessed by measuring the weight of solids in the system and assuming constant biological activity

If:

- 1 cronut burger per person
- How many cronut burger can 18564 kg of people eat?



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## Conventional Methods

Estimating Biomass Using MLSS & MLVSS



- **MLSS** = Active Biomass + Dead Biomass + Non-biological solids + Organics + Others
- Suspended solids are slow to respond to process changes.  
Mass of live bugs  $\approx$  Mass of dead bugs
- VSS measurements are slightly better, but also include dead biomass and other organics.
- Not a true measure of biomass!

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## Conventional Methods

Organics Determination – BOD & COD

	Biological Oxygen Demand (BOD)	Chemical Oxygen Demand (COD)
<b>Description</b>	Amount of oxygen consumed during microbial degradation of contaminants in water.	Amount of oxygen consumed during chemical oxidation of contaminants in water.
<b>Analysis Time</b>	5 Days at 20°C	2-3 Hours (Typical)
<b>Organics Determination</b>	Indirect	Indirect
<b>Interferences</b>	Chlorine, Salts, Sanitizers	Chlorides, Nitrites, Sulfites, Oxidizable Inorganics
<b>Reproducibility</b>	> ±15%	±10%
<b>Measurement Technique</b>	Dissolved oxygen probe is used to monitor amount of dissolved oxygen removed from solution	Colorimetric determination of reduced dichromate which is then correlated to the amount of oxygen consumed
<b>Other Considerations</b>	May Require Manual Dilution Non-Linear Response	Requires Toxic Mercury & Dichromate Generates Hazardous Waste May Require Manual Dilution

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## Key Points

- **BOD/COD is a surrogate measure for food/organics**
- **Measures oxygen consumption**
- **Organics concentration are inferred and not reliable**
- **MLSS and MLVSS is a surrogate measurement of biomass**
- **Measures solids, not active biomass**
- **Without true understanding of active biomass, can lead to excess solids, adversely impacting d/s processes**



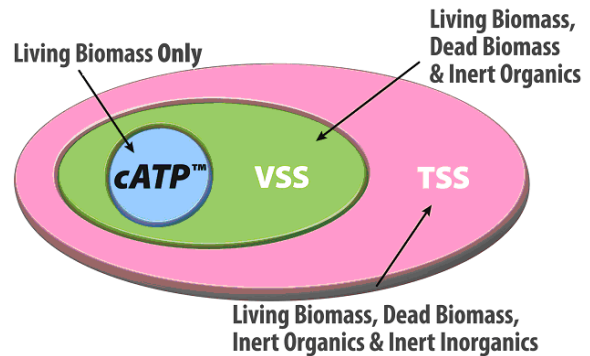
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## The True F:M Advantage

### Cellular ATP (cATP)

- cATP: Quantity of living biomass in the process;
- Represents treatment potential of the bioreactor;
- Very responsive to process changes.
- Convert to Active Volatile Suspended Solids (AVSS) using established conversion factor
- Proportion of solids inventory that is alive.



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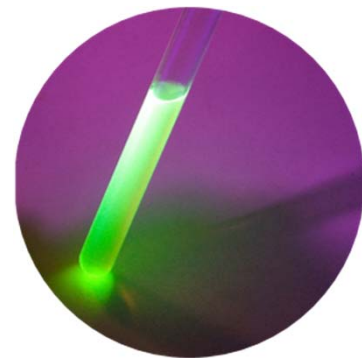
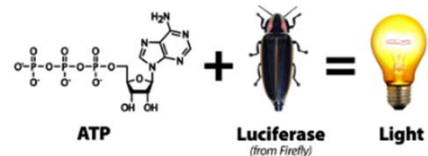
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## The True F:M Advantage

### ATP Basics

- Adenosine triphosphate (ATP) is associated with cellular energy in all living cells.
- Quantify the size of the total population.
- Measured via firefly luciferase reaction.
  - ATP + luciferase = light = microbes.
- 1st Generation ATP technology successfully used in food sector for decades.
- 2<sup>nd</sup> Generation ATP applicable to nearly any water-related industry



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### The True F:M Advantage

Total Organic Carbon (TOC)




**Oxygen Consumption ≠ Food**



**Carbon = Food**

Total Organic Carbon (TOC)	
$Organics + Na_2S_2O_8 \xrightarrow{Heat, Pressure} CO_2 + H_2O + Na_2SO_4$	
<b>Description</b>	Direct quantification of the total amount of organic carbon in solution. Includes all carbon-hydrogen containing compounds which are amenable to oxidation
<b>Analysis Time</b>	< 7 Minuets
<b>Organics Determination</b>	Direct
<b>Interferences</b>	None
<b>Reproducibility</b>	±3%
<b>Measurement Technique</b>	Dissolved oxygen probe is used to monitor amount of dissolved oxygen removed from solution
<b>Other Considerations</b>	

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### The True F:M Advantage

Real Time Monitoring With TOC + cATP

- What This Allows Us To DO:
  - “Dial in” the optimum F:M ratio for biological systems
  - Measure actual parameter (not a surrogate)
  - Run in real time
  - Determine actual “optimum ranges”
  - Optimize C/N/P ratios
  - Optimize Blower operations
- In doing so, we move this from a theory or guess, to an actual real operating parameter and operational target.


**Operate By Data...Not Design!**

Establish  
Baseline

Detect Change

Take Corrective  
Action

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## Case Study: Implementing the True F:M Approach at a Refinery WWTP Southern California (USA)

### The Challenge

- Unsteady bioreactor performance, with variable conventional F:M levels and DOC removal
- Highly fluctuating food levels sent to the bioreactor

### Our Solution

- Replace conventional F:M biological control using BOD and MLSS with "True F:M" using TOC and cATP.
- Measure values in real-time to make immediate process decisions.

### Results

- Determined the precise "True F:M" ratio needed for optimal treatment.
- Shifted from running by design to running by data.
- Maintained steady state biological treatment system and eliminated reseeded and regrowth



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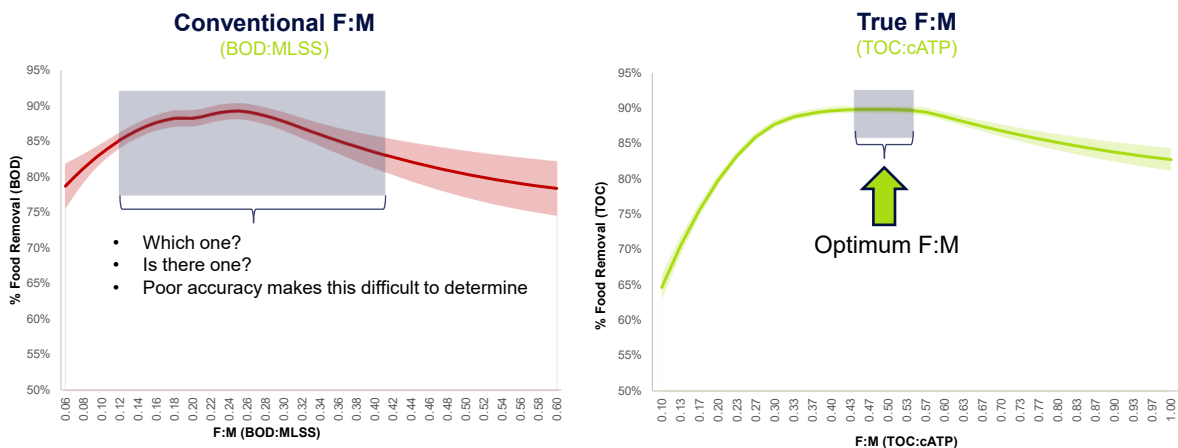
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## Case Study

Compare Conventional to True F:M

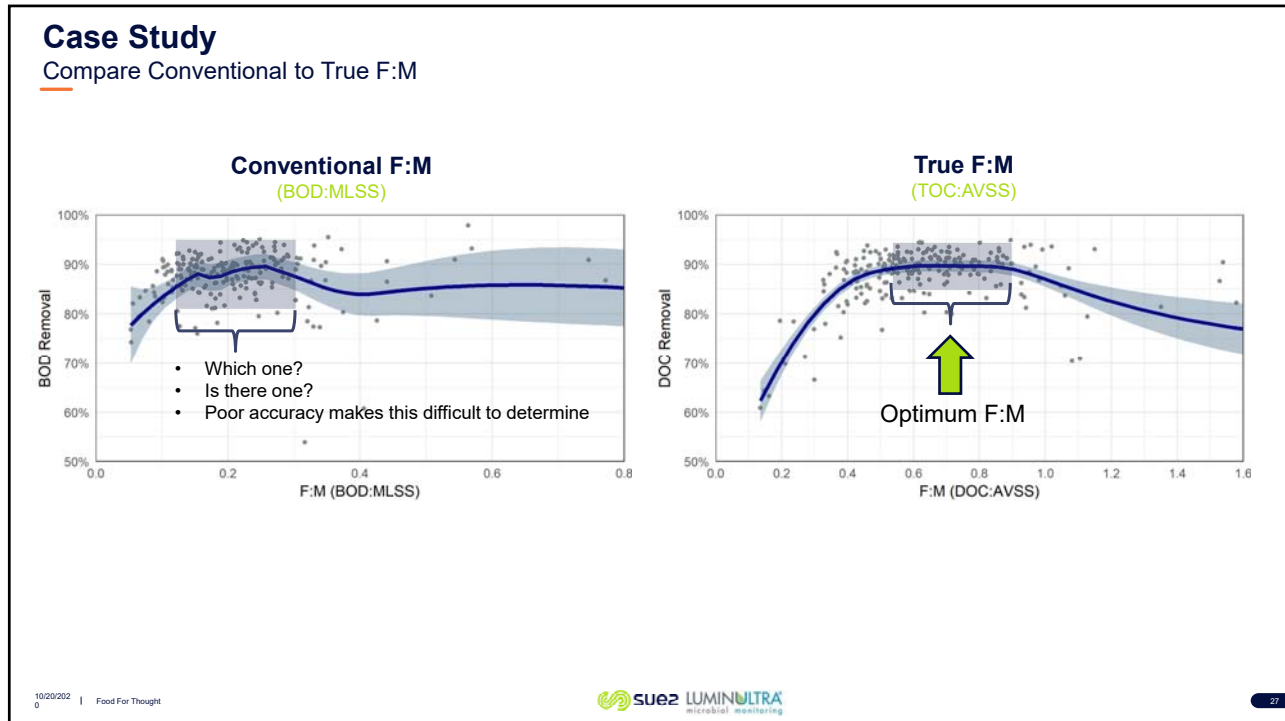


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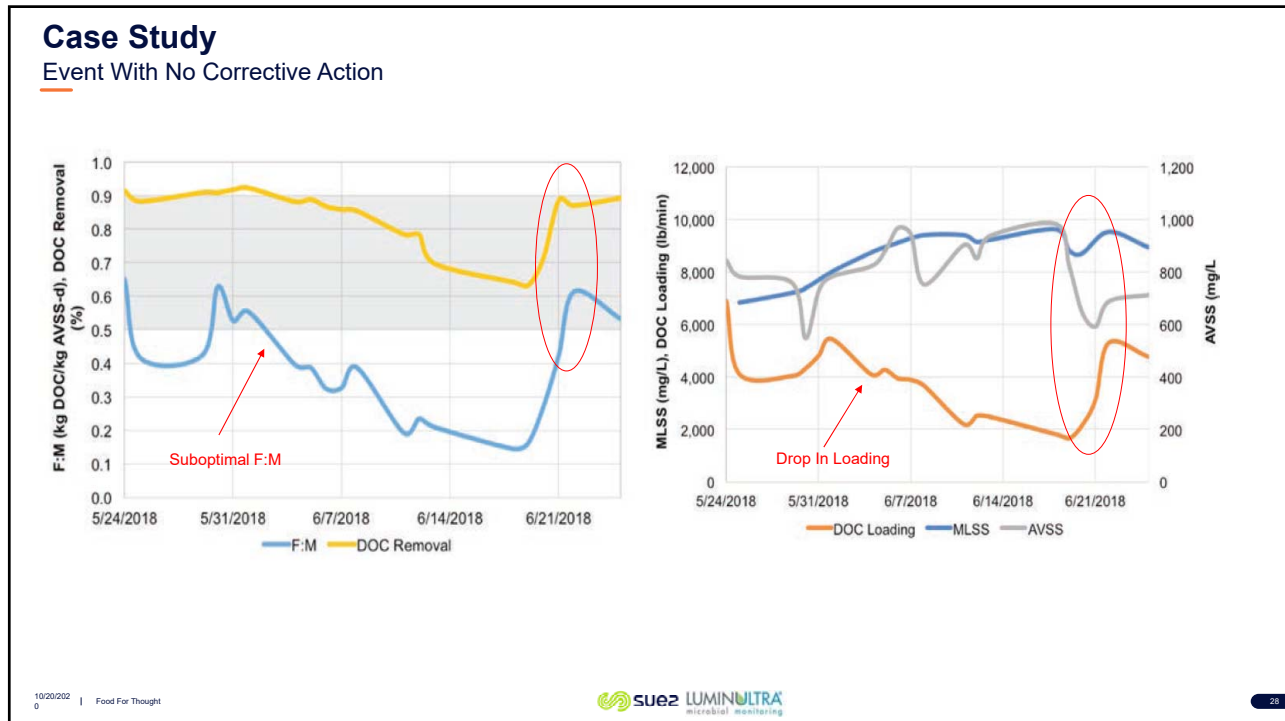
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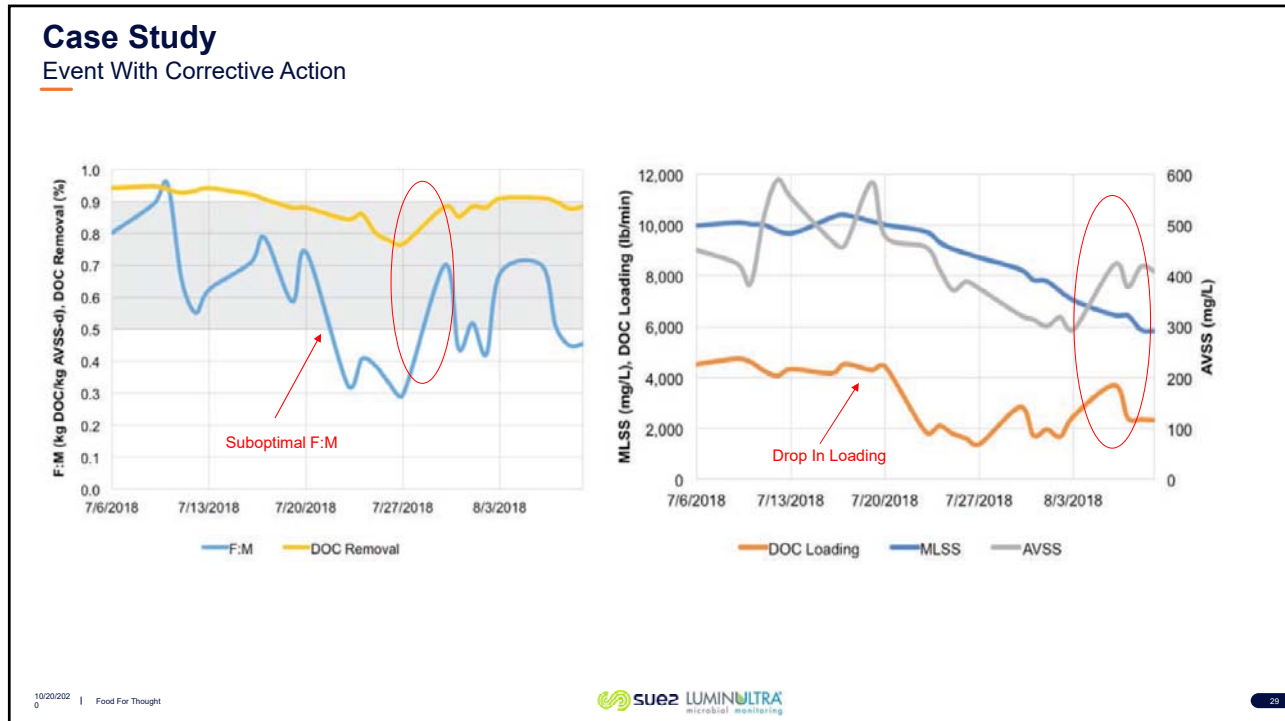
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### The True F:M Advantage


Real-Time Monitoring With TOC + cATP




**Rapid**  
Online TOC and ATP results in five minutes means F:M can be determined quickly, with changes made in real-time, rather than hours later.



**Clear Optimum Range**  
Optimum range was easily identified. Relationship between conventional approach and performance was less obvious



**Effective Measures**  
DOC and AVSS proved to be accurate measures of food and active biomass. Eliminates site-to-site variability associated with TSS.



**Adaptable**  
Can be used with other processes, such as MBR, MBBR, where conventional F:M is difficult to measure.

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## The True F:M Advantage

Why does this matter

### Reduced upsets

- Protect the environment and reputation, and reduce fines

### Optimize energy consumption and process performance

- Aeration is the #1 user of energy and aeration efficiency is greatly impacted by dry solids concentration
- Reduce overall solids handling on downstream processes

### Makes operators lives easier

- Troubleshooting is faster



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# Questions?



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