A LOW-LEVEL COD MEASUREMENT TOOL FOR RAPID PROCESS PERFORMANCE CHARACTERIZATION IN REUSE TREATMENT APPLICATIONS

September 15, 2015

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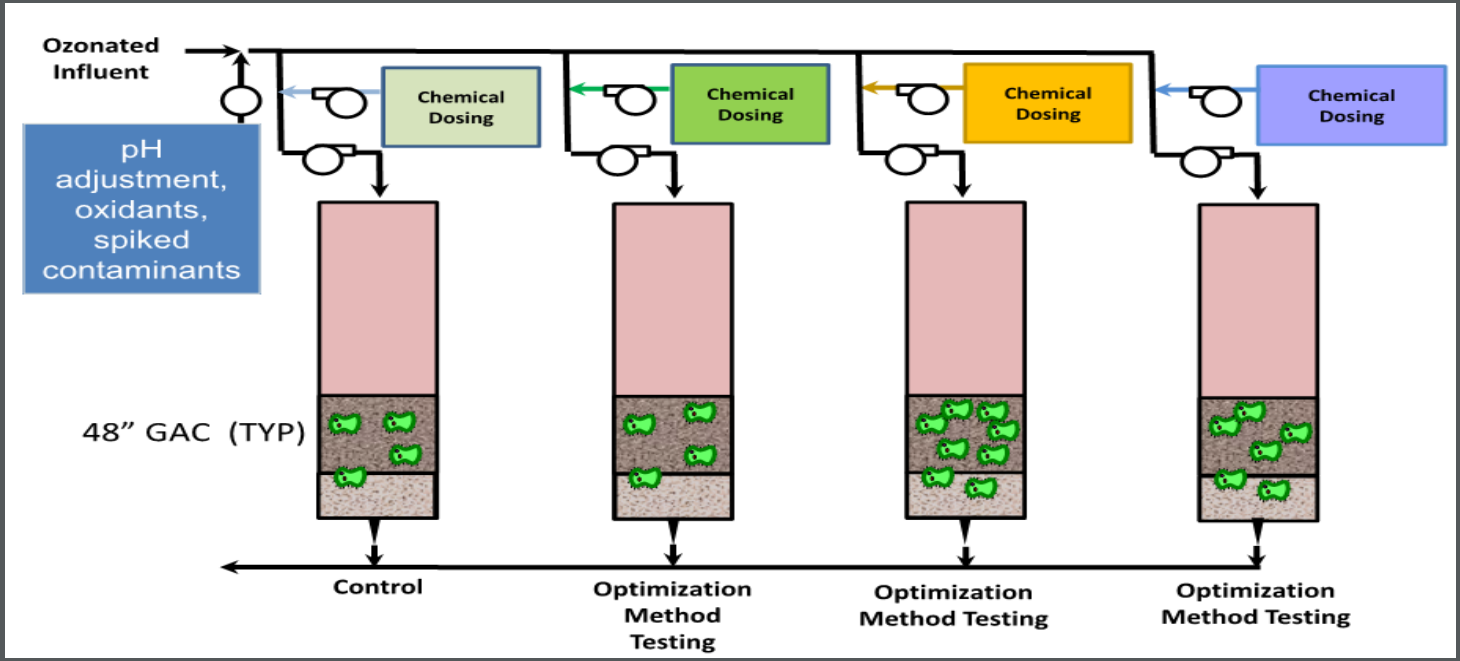
WHAT ARE WE GOING TO SEE TODAY…

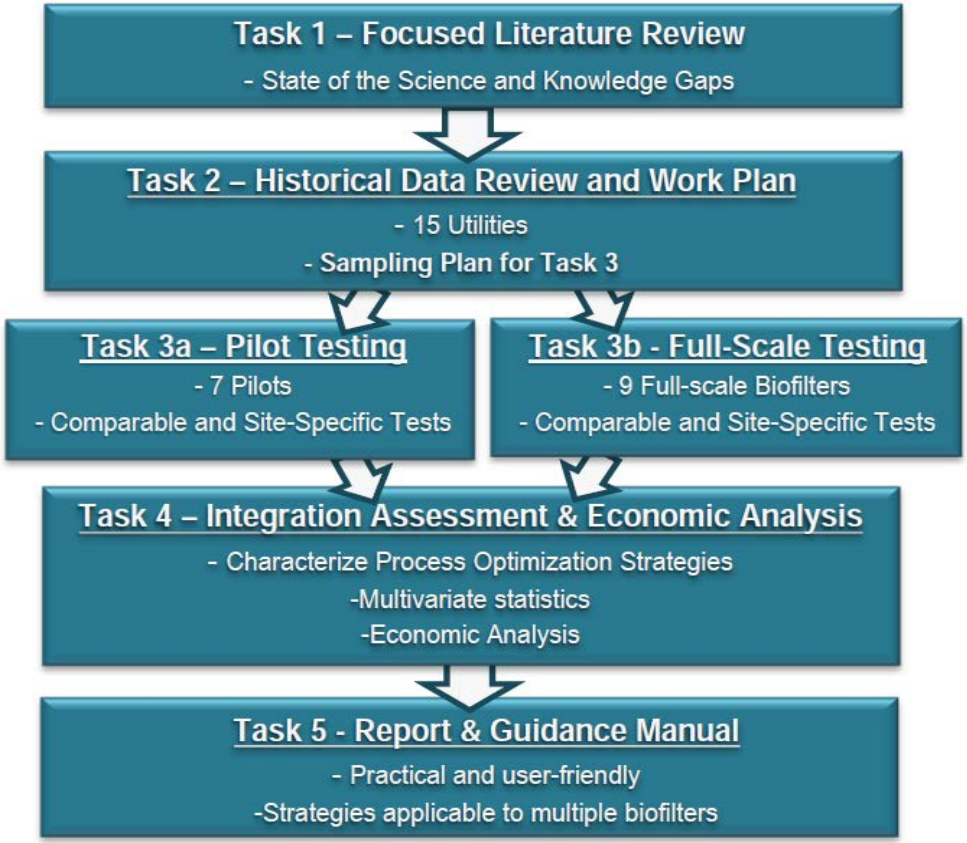
- Introduction to the parent research project
- Background and drivers for biostability measurements
- Fundamentals of the PeCOD analyses
- Initial findings and discussion
- Upcoming investigations



WRF 4555 "OPTIMIZING BIOFILTRATION FOR VARIOUS SOURCE WATER QUALITIES"

Overall Objective: Identify enhancement strategies that yield reliable, sustained, and robust achievement of treatment and operational goals across multiple source water qualities

Project Components

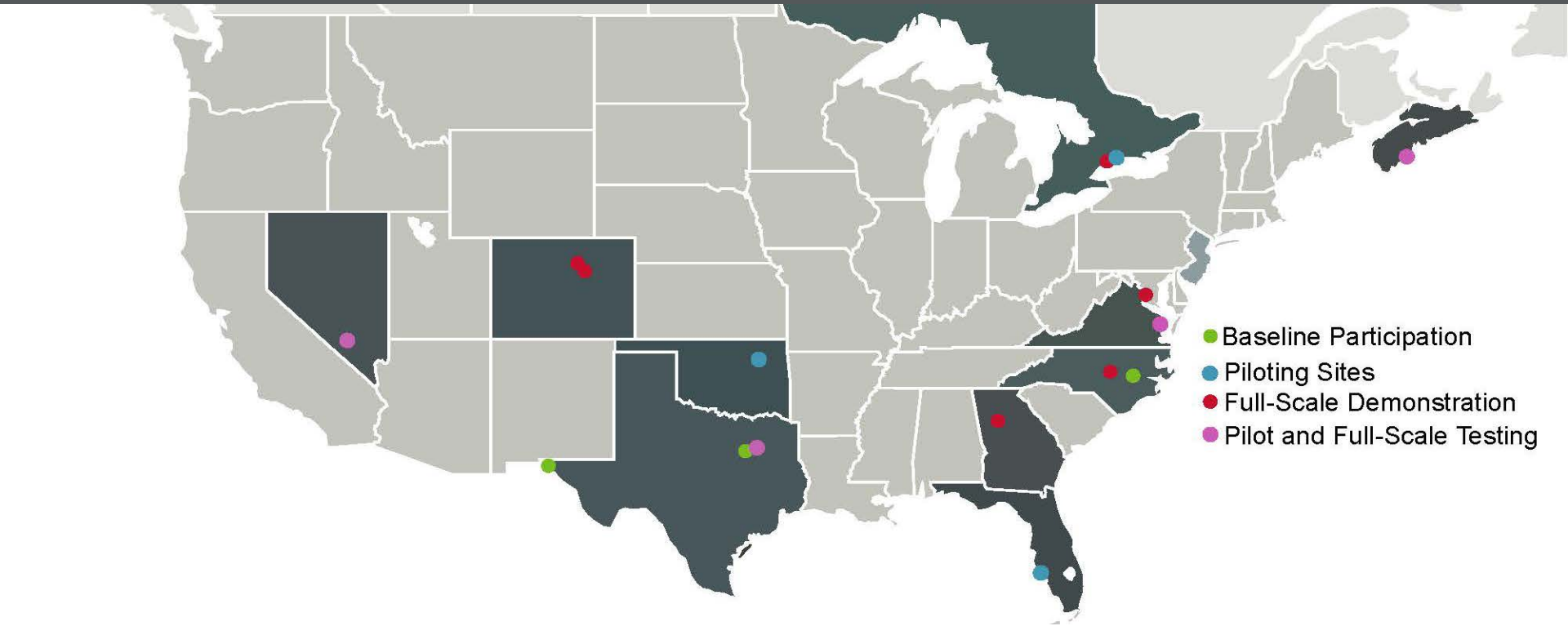


SPECIFIC OBJECTIVES

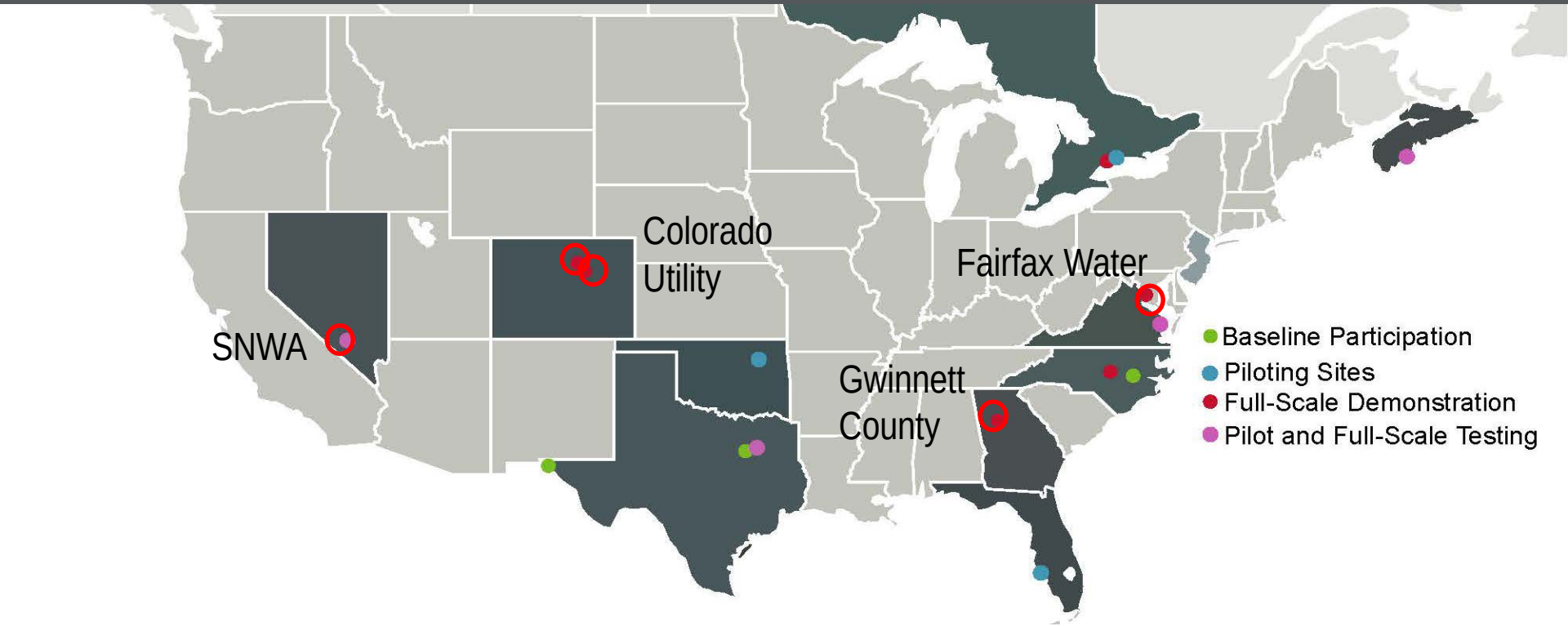
- Assess the impacts of upstream treatment process water quality on downstream filtration;
- Develop a method for preservation of filtration (particle removal) performance and filter production, regardless of source water conditions;
- Establish a protocol for reliable operation and delivery of stable effluent that meets or exceeds primary and secondary standards.
  - Validate efficacy and broad applicability existing biofilter performance monitoring tools
  - Identify and characterize new tools that may hold additional benefits

Optimization Strategies Considered in WRF 4555

- Upstream Processes
  - Coagulation/Sedimentation (coagulants, pH, others)
  - Oxidation (permanganate, ozone, chlorine)
- Enhancing Microbial Activity
  - Nitrogen/Phosphorus Supplementation
  - Trace Metals Supplementation
- Filter Backwashing Strategy
  - Dechlorinated Backwash
  - Backwash Duration/Frequency
  - Air Scour vs. Sweeps
  - Filter Aid Addition
- Media Design
  - GAC/Anthracite, Filter Caps



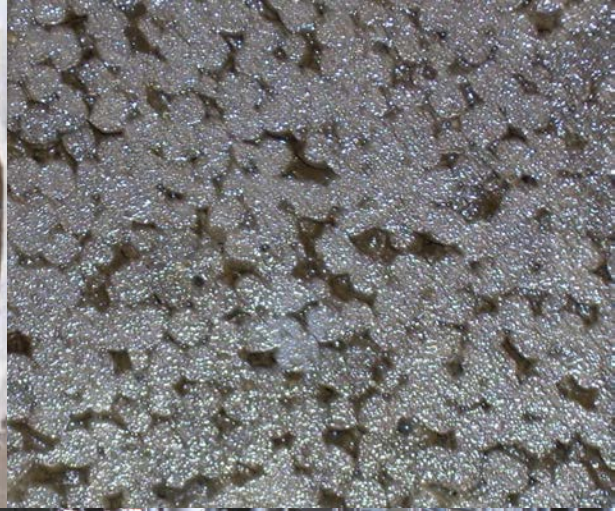
WRF 4555 INCLUDES OVER 15 PARTICIPATING DRINKING WATER UTILITIES THAT ARE PERFORMING BIOFILTRATION OPTIMIZATION PILOT AND FULL-SCALE STUDIES

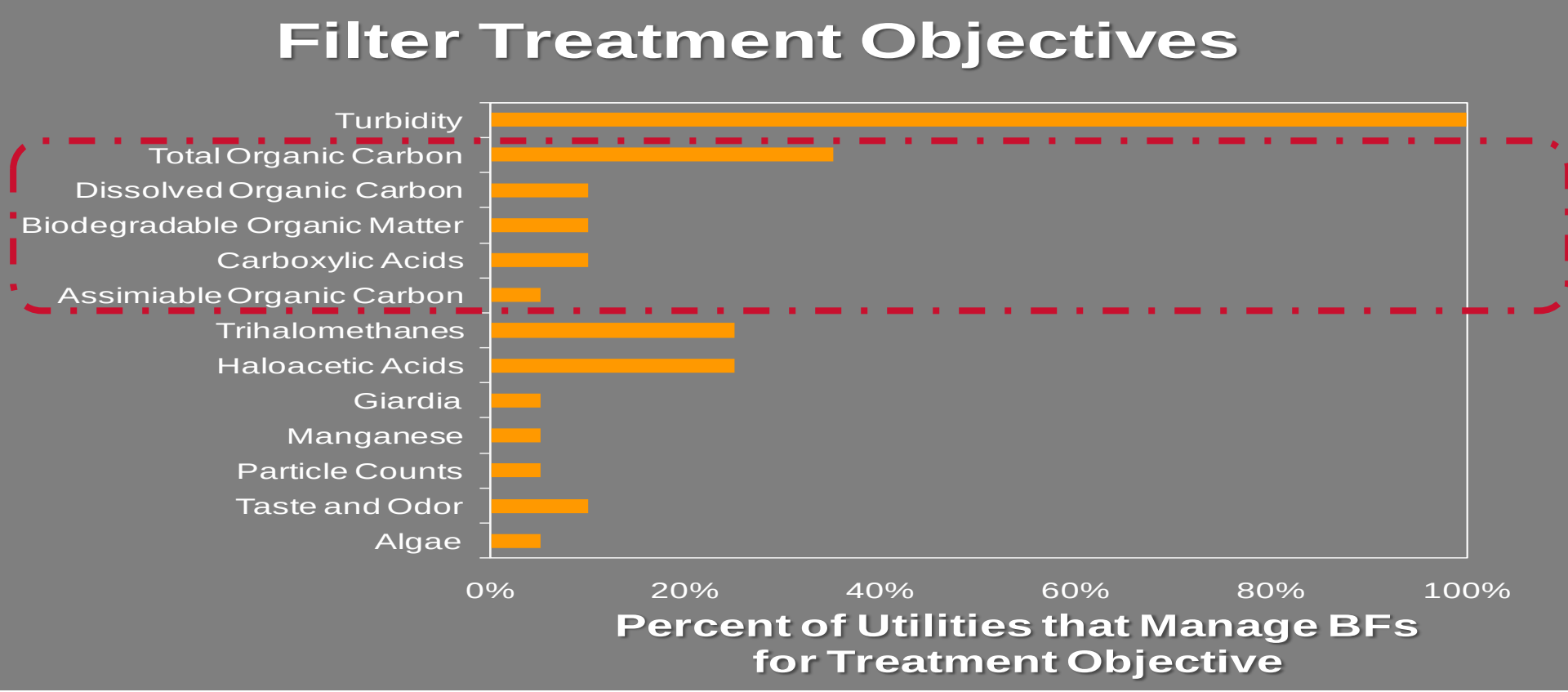


SEVERAL TEST LOCATIONS INCLUDE SOURCE WATERS (OR ALTERNATIVE TESTED SOURCE WATERS) THAT CAN BE PREDOMINATED BY WASTEWATER INFLUENCE

Substrate Removal is a Critical Driver for Biofiltration at All Facilities

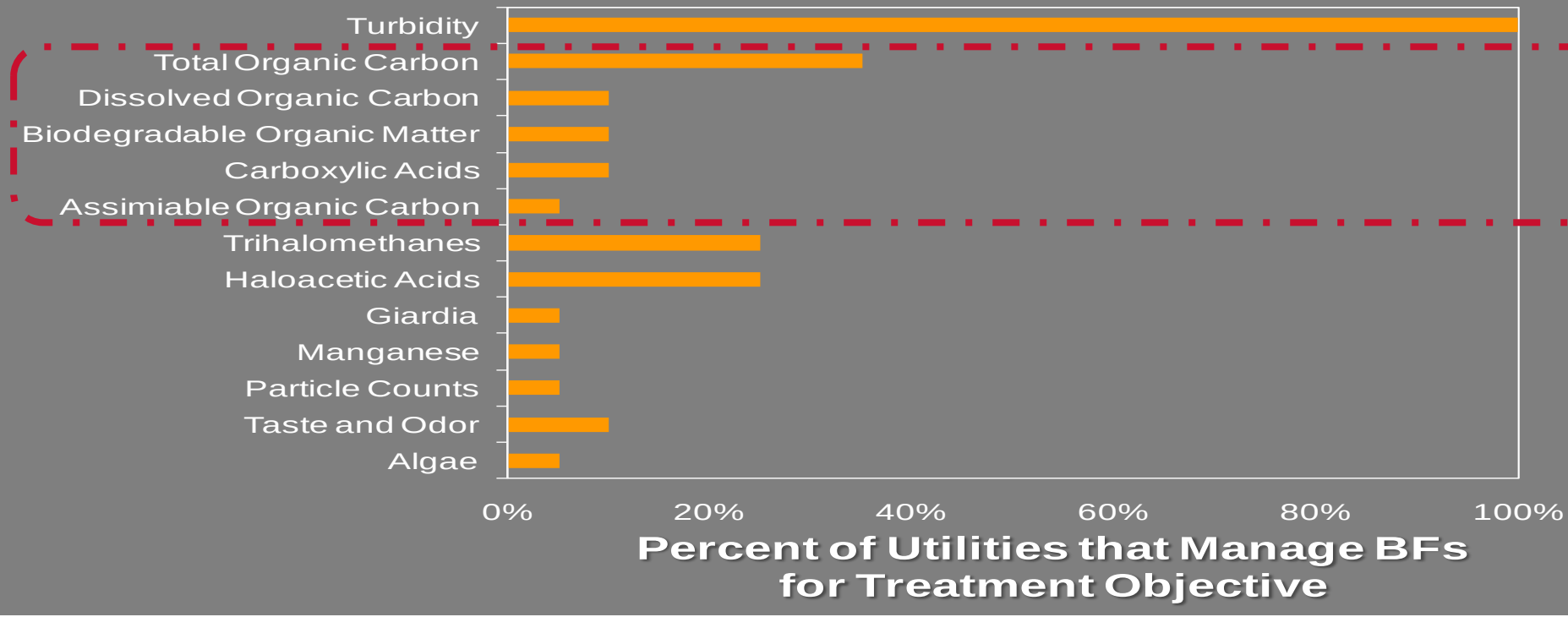
- Improve finished water biostability
  - Decrease regrowth
  - Improve residual disinfectectant stability
  - Improve tap aesthetics
- Decrease downstream disinfectant demands
- Decrease disinfection by products and other organic intermediates created by upstream processes





MANY UTILITIES MONITOR SUBSTRATE REMOVAL FOR BIOFILTRATION PERFORMANCE ASSESSMENT (WRF 4231)

Filter Treatment Objectives

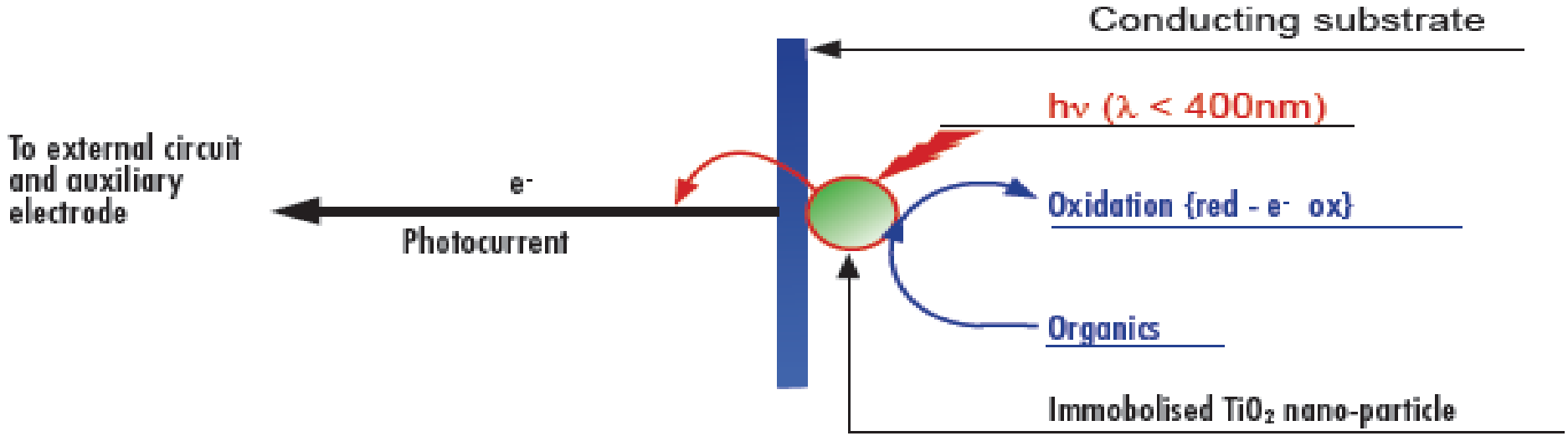


NEW METHODS MAY PROVIDE OPPORTUNITIES TO FURTHER IMPROVE COST, USEFULLNESS, EASE OF USE, AND/OR DATA QUALITY SENSITIVITY OVER EXISTING PRACTICES

Parameter	Cost	Usefulness	Ease of Use	Sensitivity
TOC	Low	Low	Moderate	Low
DOC	Low	Low to Moderate	Moderate	Low
BDOC	High	Moderate	Low	Low
Carboxylic Acids	Moderate	Moderate to High	Low to Moderate	High
AOC	High	Moderate to High	Low	High
UVvis	Low	Low to Moderate	Moderate to High	Moderate

Photoelectrical COD Analysis is an Alternative Monitoring Technique for Biofiltration Stability/Substrate Removal

- Alternative method for COD analysis
- Potential biofiltration performance and biostability monitoring tool
- May hold advantages over existing toolbox of organic substrate/biostability analytical techniques
  - Low analytical time
    <5 minutes per sample
  - Low cost
    <$5 per sample after initial investment
  - Potential for low level sensitivity
    ~0.01 mg/L COD

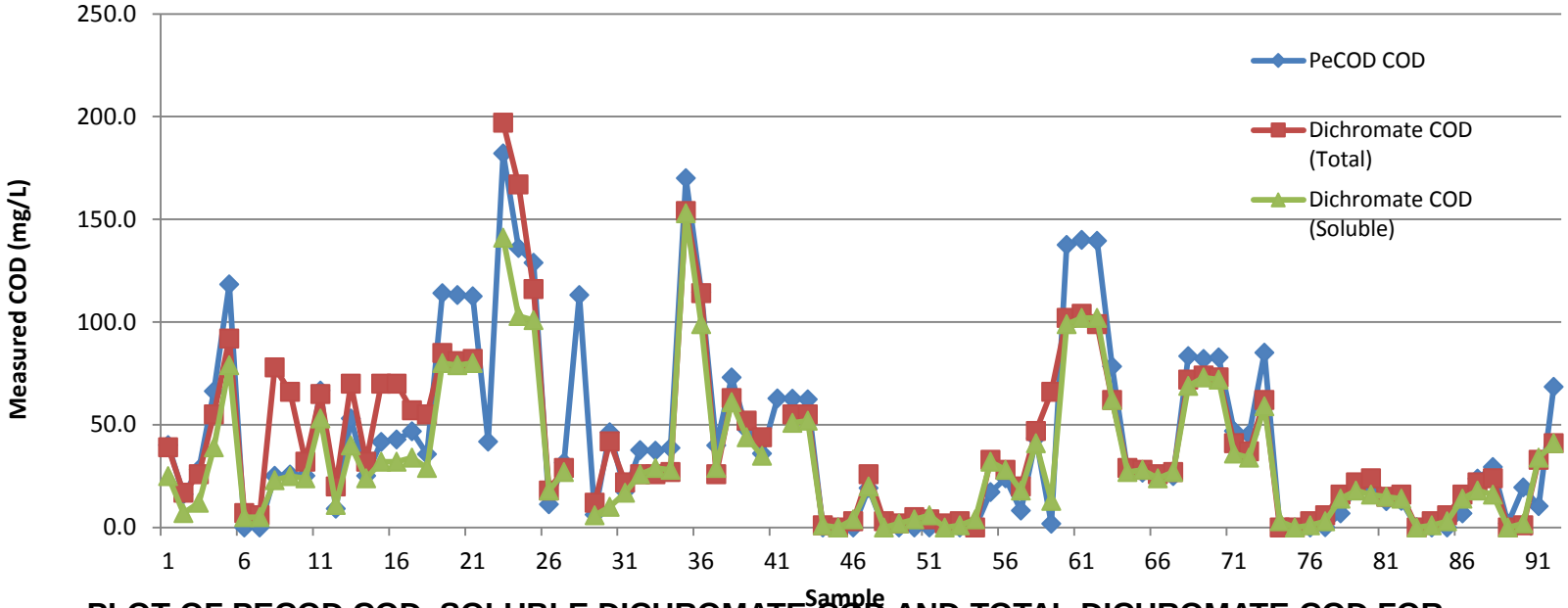


Schematic of the photo-electrocatalytic process involved in the analytical signal generation

PRINCIPLES OF PHOTOELECTRICAL CHEMICAL OXYGEN DEMAND

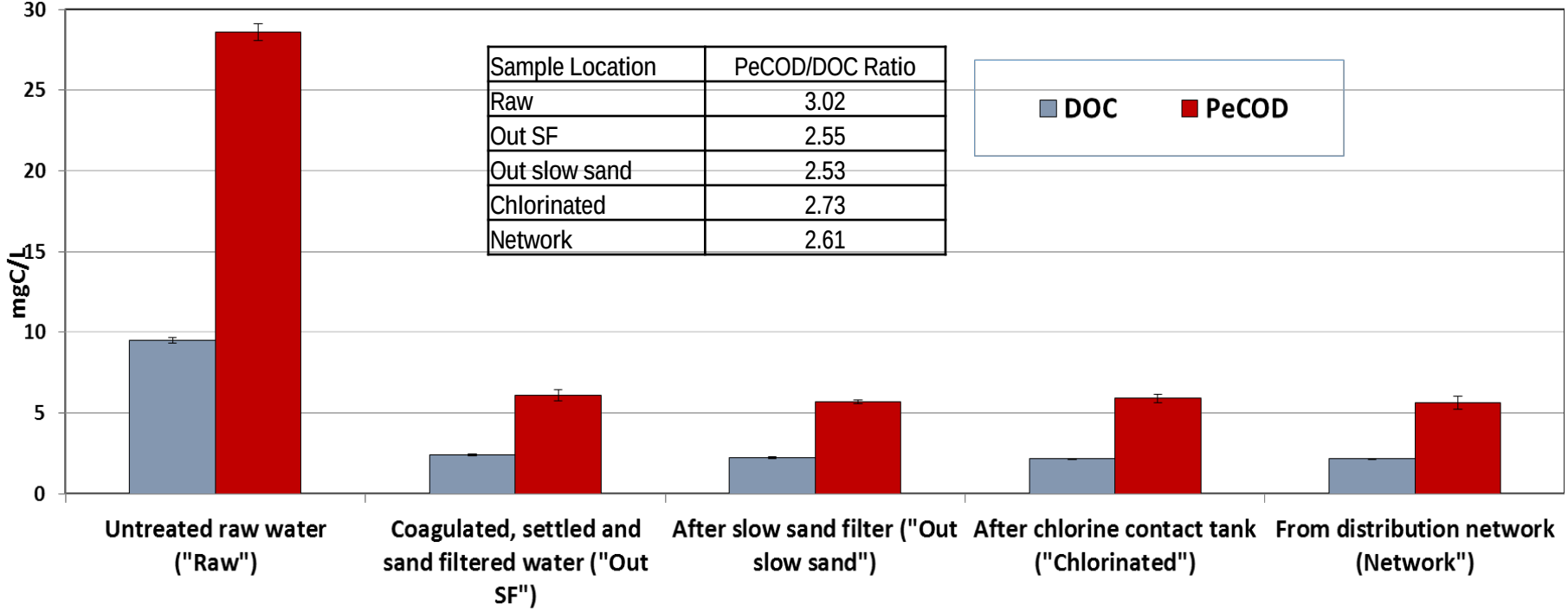
Courtesy of Mantech, Inc.

Manufacturer Provided Data Shows Good Correlations with Traditional COD Measurement in Surface Waters



PLOT OF PECOD COD, SOLUBLE DICHROMATE COD AND TOTAL DICHROMATE COD FOR SURFACE WATER SAMPLES FROM THE ATHABASCA WATERSHED IN ALBERTA, CANADA. (EXPERIMENTS CONDUCTED BY ENVIRONMENT CANADA AT NATIONAL LABORATORY FOR ENVIRONMENTAL TESTING)

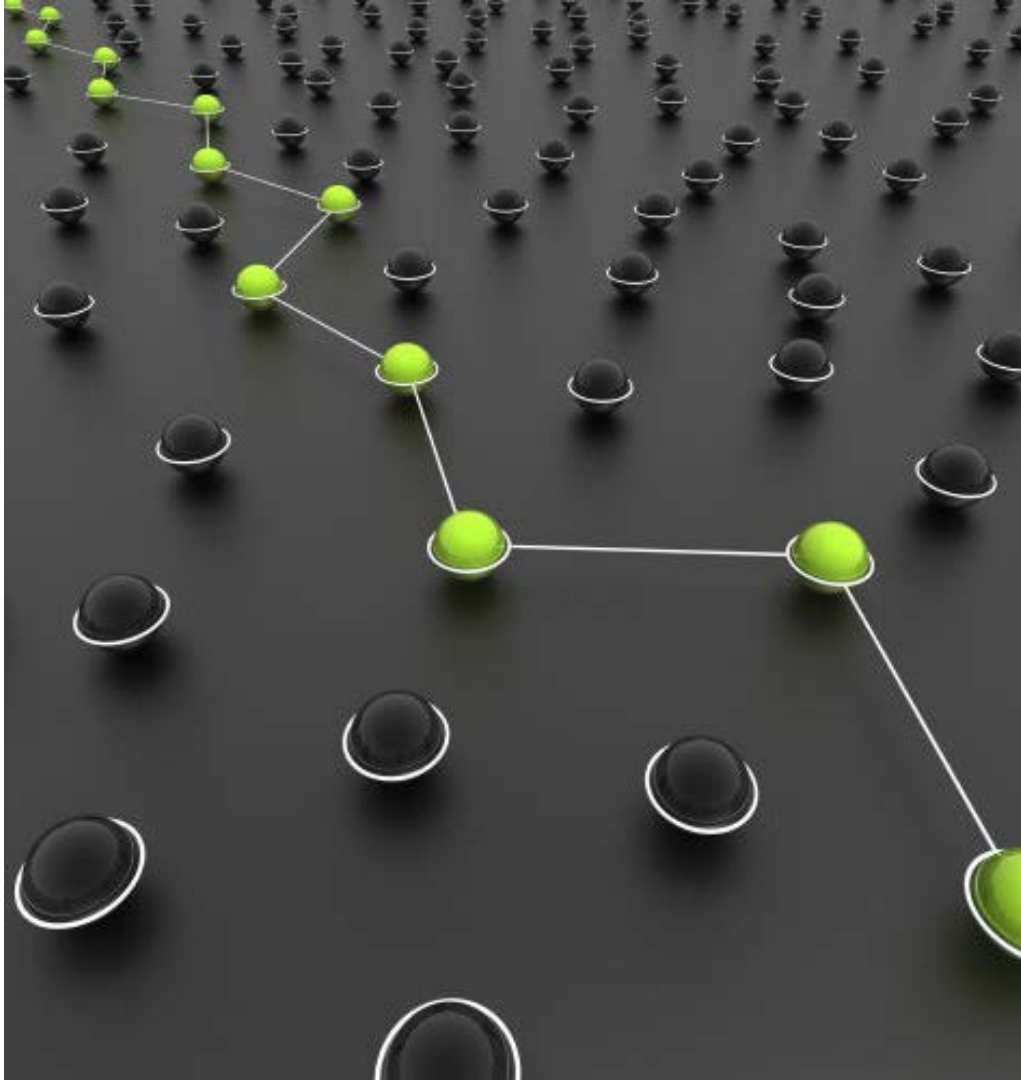
Manufacturer Provided Data Shows Interesting Correlations Between DOC and Photoelectric COD Measurement Across Treatment Trains (Experiments conducted by the Centre for Water Resource Studies, Dalhousie University)



Sample Location	PeCOD/DOC Ratio
Raw	3.02
Out SF	2.55
Out slow sand	2.53
Chlorinated	2.73
Network	2.61

Photoelectric Chemical Oxygen Demand Evaluation Criteria (Ongoing)

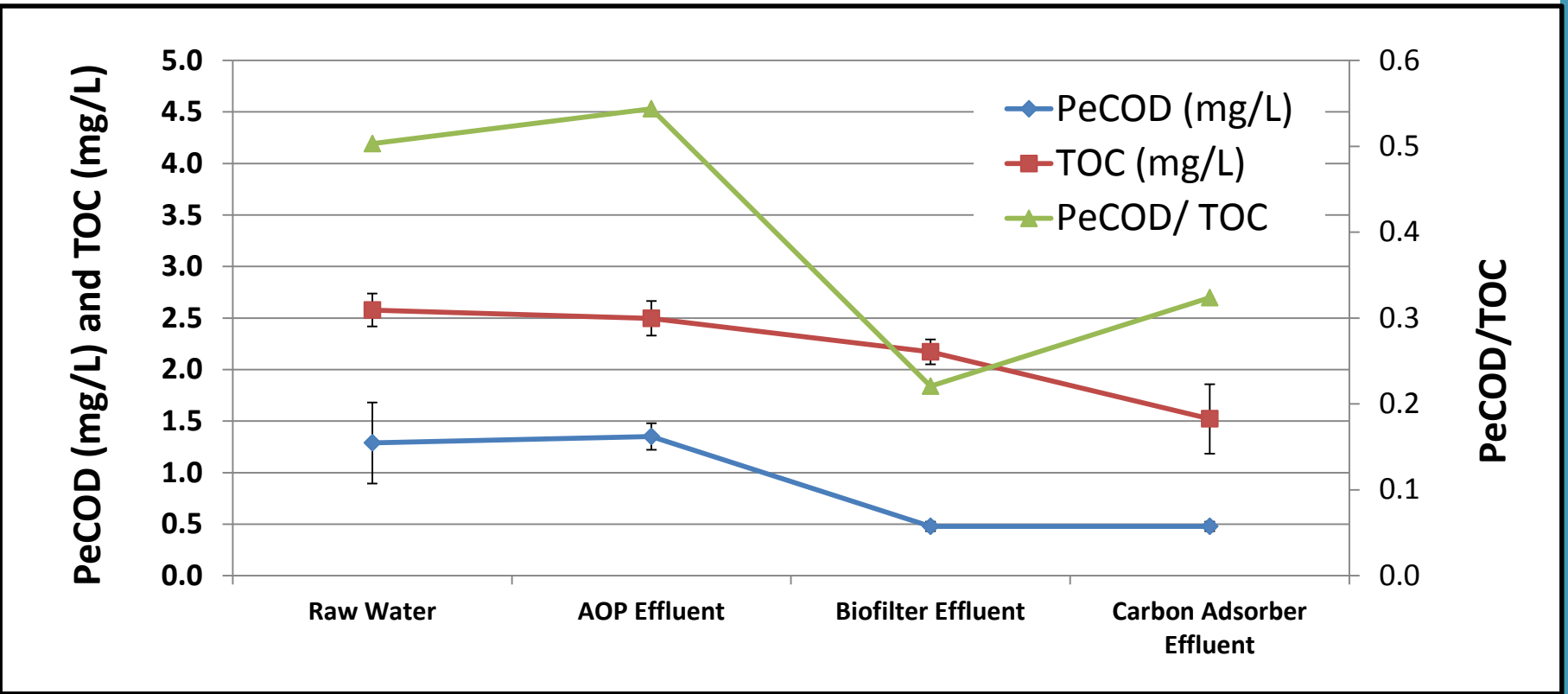
1. Repeatability of testing, confidence in data
2. Confirm low resolution testing for biofilter/DW applicability (<0.1 mg/L)
3. Characterize changes in Photoelectric COD across treatment trains and for various water qualities
4. Correlate data to other biofilter performance and/or stability criteria



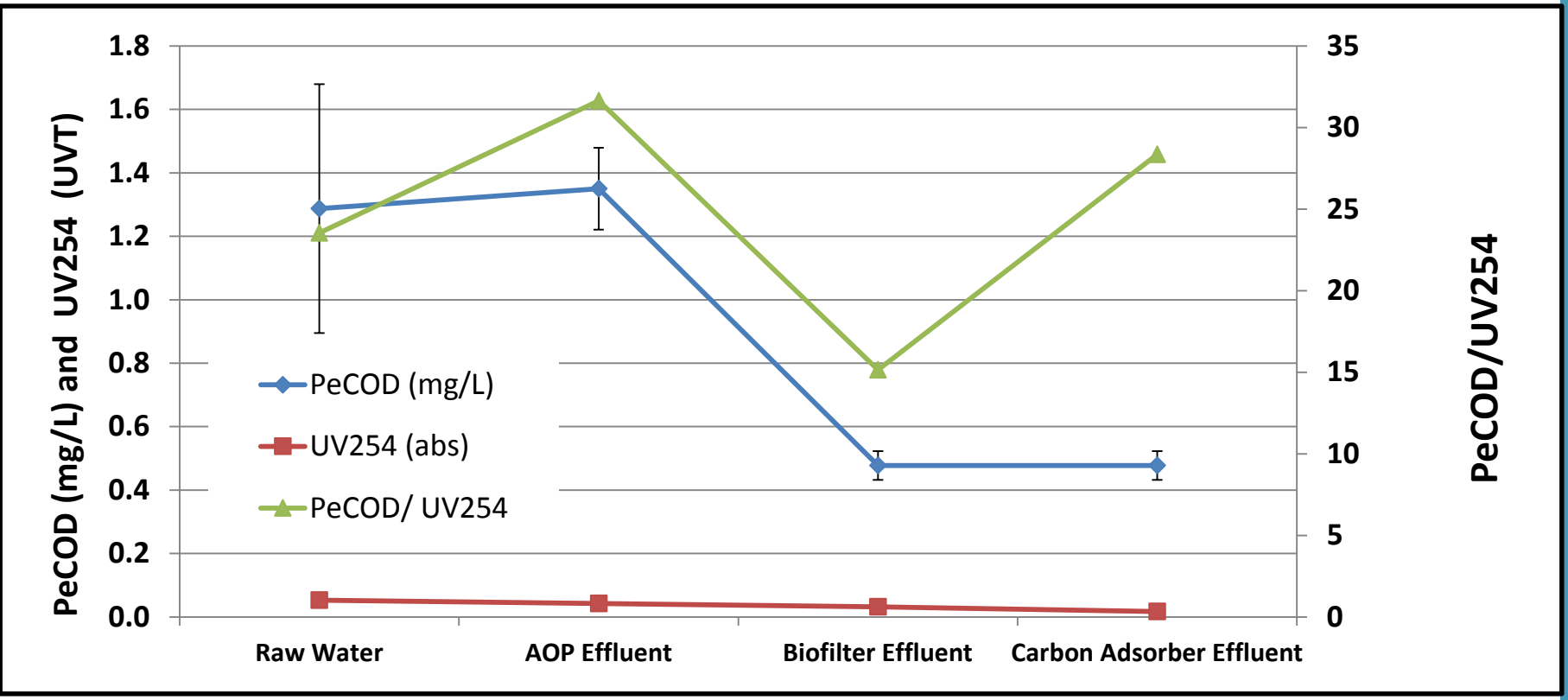
Initial WRF 4555 Pilot Data Suggests that PeCOD Analysis May Provide Additional Characterization of Reactive Organics Removal

Location	PeCOD	DOC	UV254	SUVA
Raw	7.7	2.8	0.159	5.7
Post Ozone	5.7	2.5	0.141	5.6
GAC Filter Effluent	4.8	2.6	0.126	4.9
Anthracite Effluent	4.7	2.5	0.130	5.2

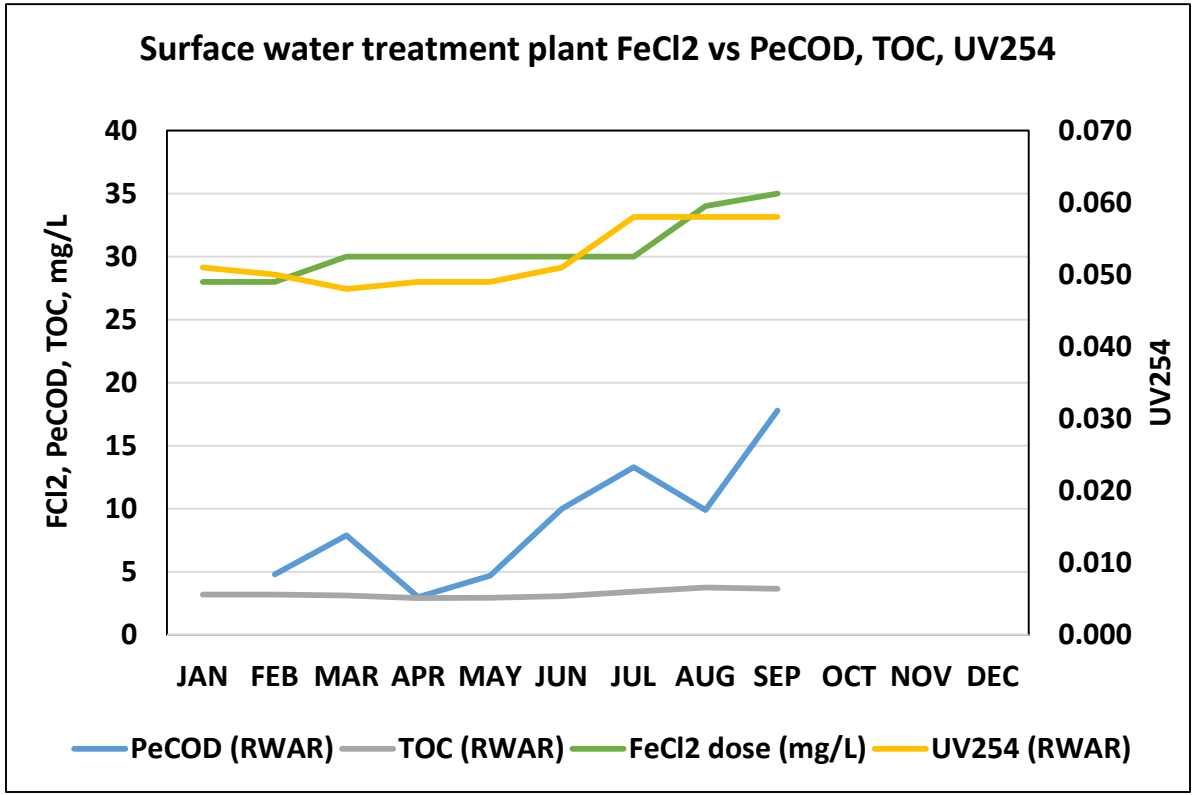
Initial Data from a Full-scale IPR Facility Indicate Relatively Higher Changes in PeCOD than TOC after Biofiltration



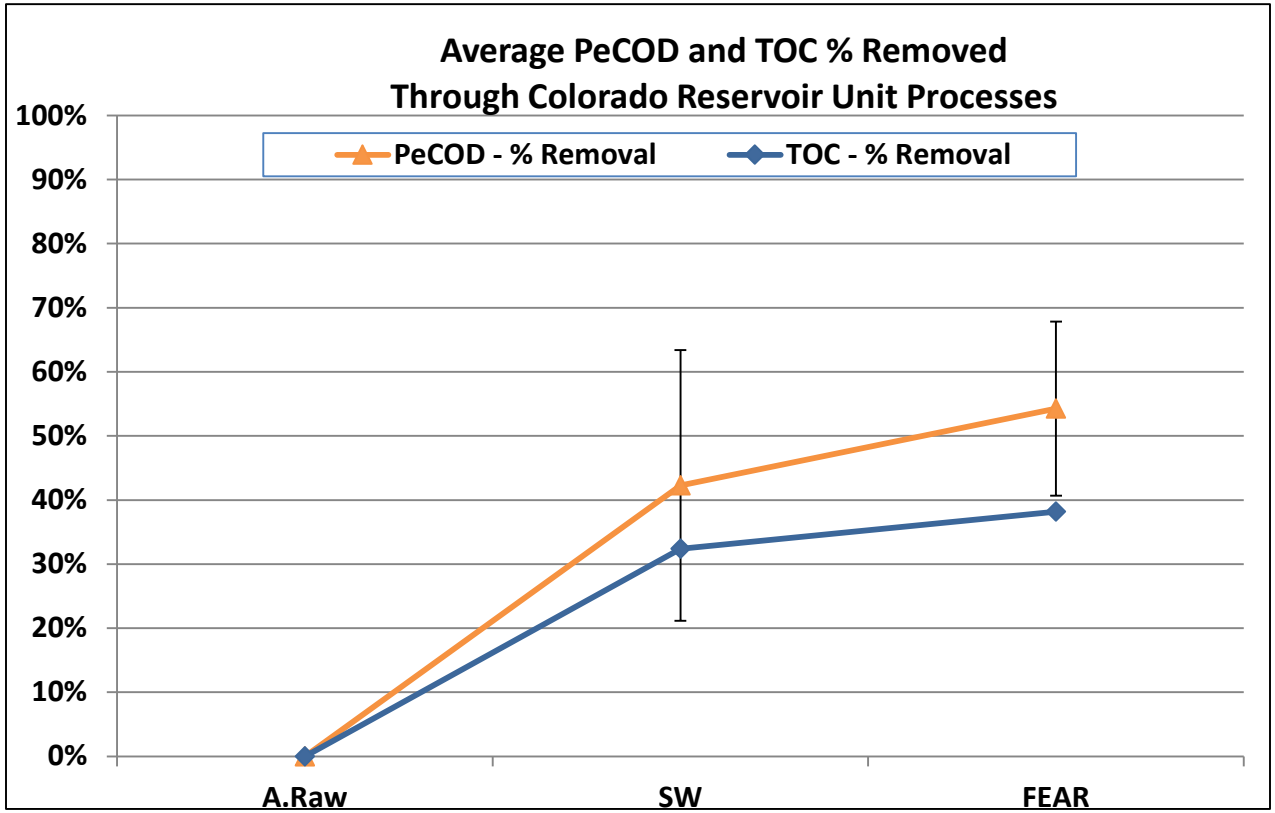
Initial Data from a Full-scale IPR Facility Indicate Relatively Higher Changes in PeCOD Than UV254 after Biofiltration



Initial Data from Colorado Utility Indicate Relatively Higher Sensitivity and More Variability in PeCOD than TOC

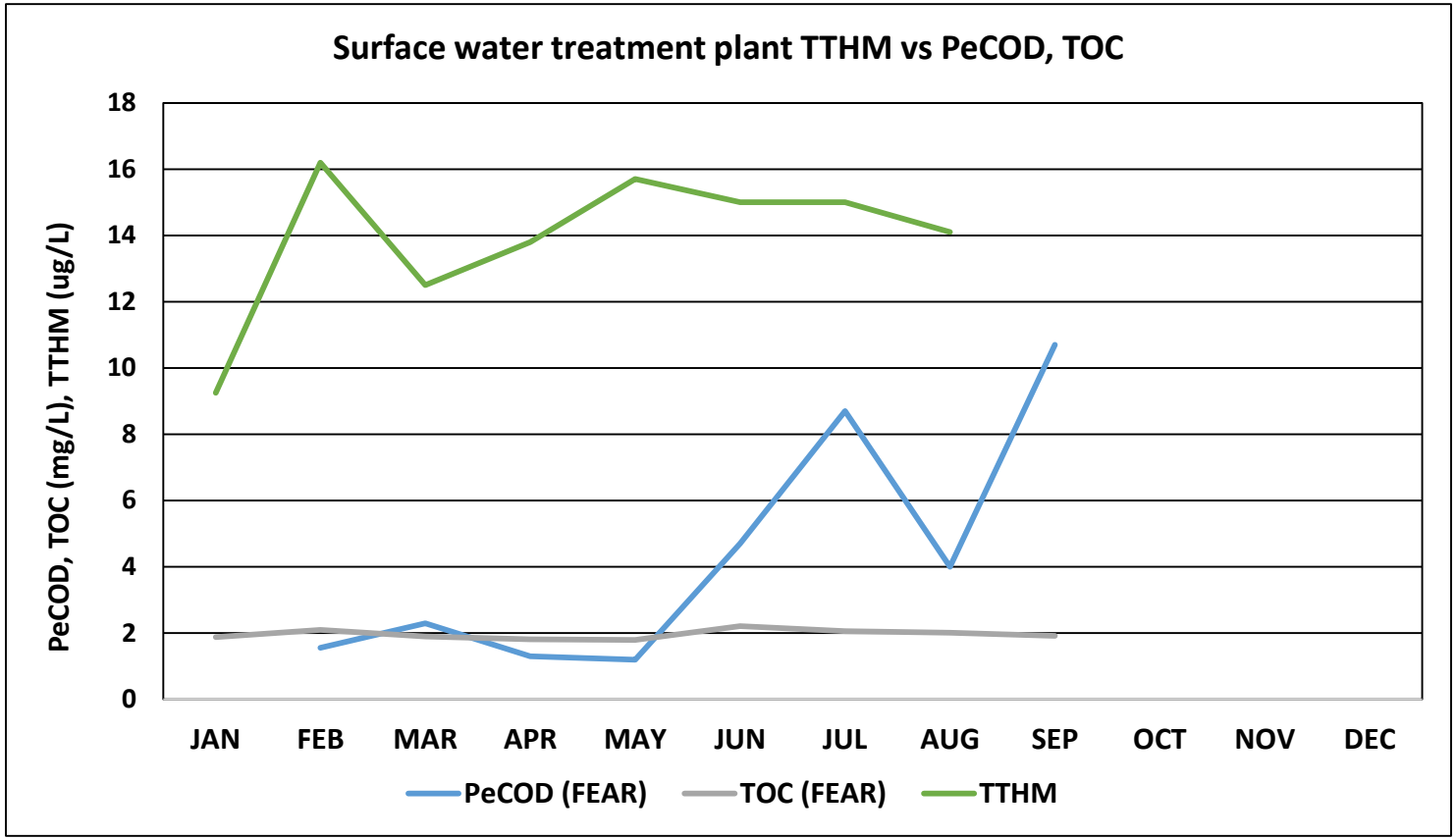


Initial Data From Colorado Utility Indicate Similar Removal Trends but Relatively Higher Sensitivity & More Variability in PeCOD than TOC

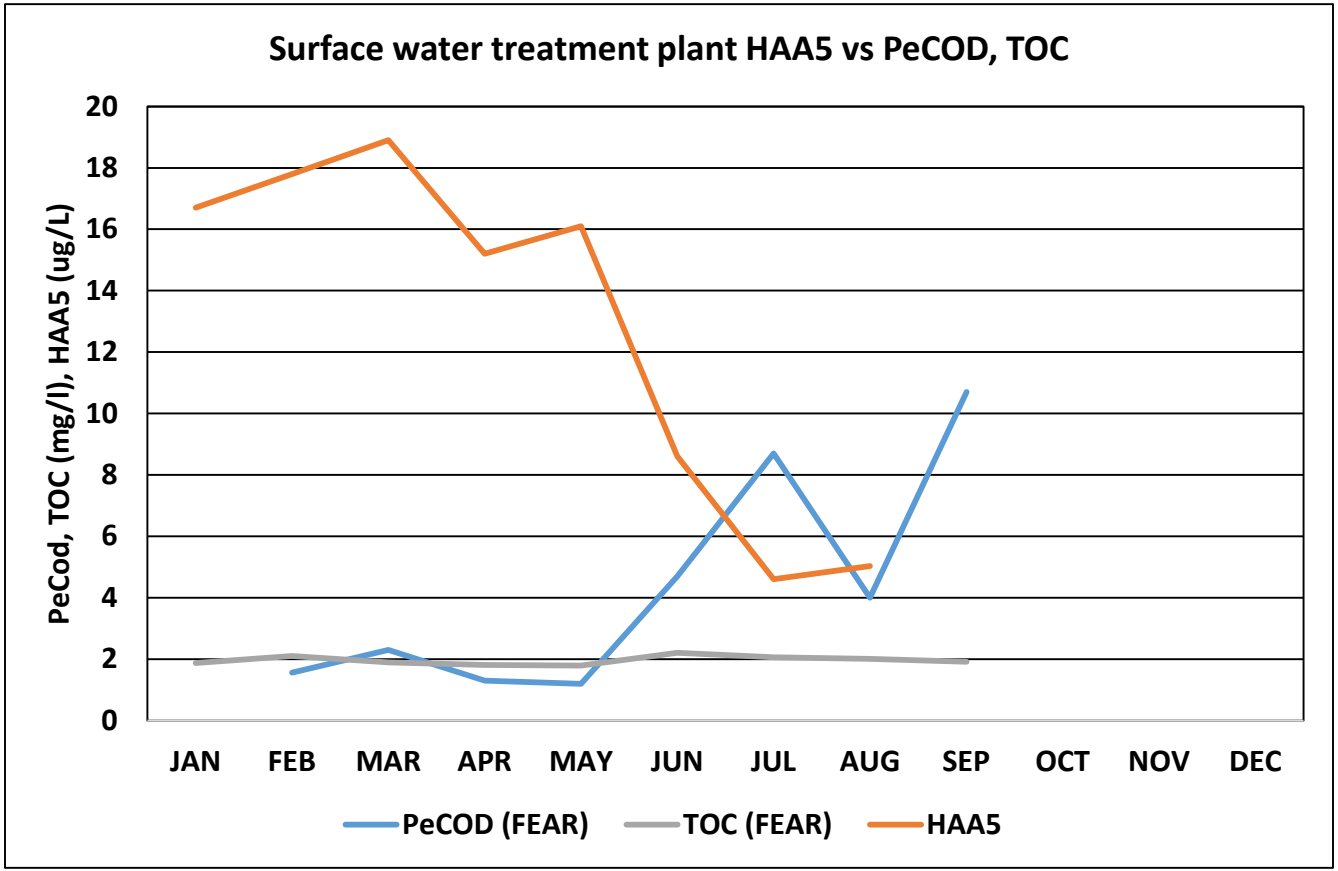


PeCOD % Removal		
Source	Average	St Deviation
SW	42%	21%
FEAR	54%	14%
TOC % Removal		
Source	Average	St Deviation
SW	32%	5%
FEAR	38%	7%

Colorado TTHM Data vs. PeCOD and TOC



Colorado HAA5 Data vs. PeCOD and TOC



PRELIMINARY CONCLUSIONS AND THOUGHTS

- The PeCOD method is a good alternative to the traditional dichromate digestion method
- PeCOD removal results track TOC removal results well across treatment processes but do exhibit greater variability particularly at the higher concentrations (ie.,raw water)
- Future evaluation will consider impact of preoxidants on BDOC, AOC and PeCOD to determine any correlations
- Data will be gathered to assess sensitivity and suitability of PeCOD as a measure of the water treatability and stability
- Other testing will be conducted to evaluate correlations between DBPs, CECs and PeCOD

QUESTIONS?

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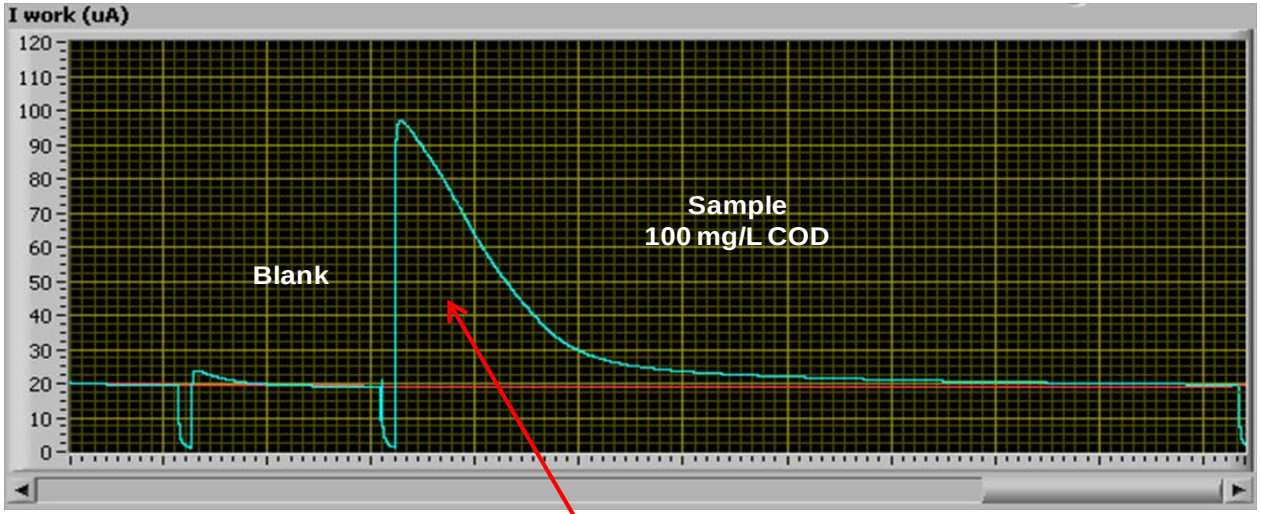
PECOD TECHNOLOGY



Time 4 min

Area under curve = Q_{net}

COD = $k \cdot (Q_{net} - Q_{blank})$

PECOD PRODUCTS

- Laboratory Analyser
  - Stand Alone
  - Automated (PeCOD AssayPlus, Multi-Parameter, PC-BOD/Titrate Duo)
  - At-Line
- Portable Field Analyser
- On-line Analyser

PECOD TECHNOLOGY