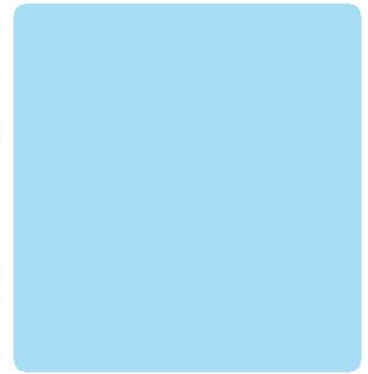
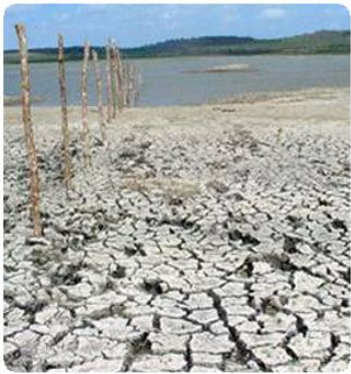




MODERNWATER

# Modern Water Microcystin Solutions for Drinking Water

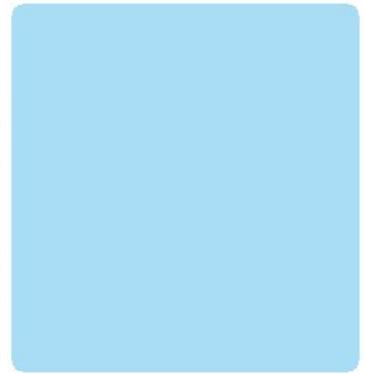
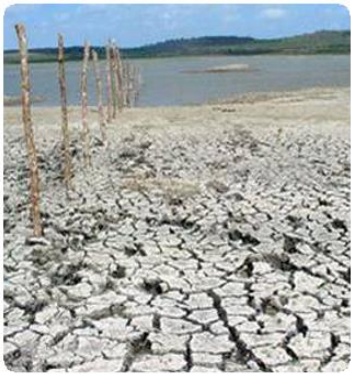
Mark Fashion – Pres. - Covenant Analytical Solutions  
& Ohio MR for Midland Scientific Inc. & Modern Water





MODERNWATER

# Why work with Mark from MSI and Modern Water?



*Bringing new technology to the water industry*

# Fashian Clan



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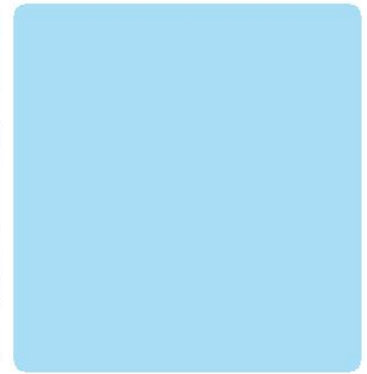
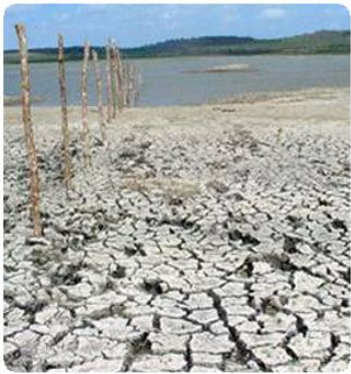




## MODERNWATER

Today's presentation:

- 1) MicroCystin Explained
- 2) Test procedures
- 3) Enviroguard ELISA
- 4) ATP Screen
- 5) RaPID Assay Screen
- 6) Microtox CTM Screen
- 7) Customers
- 8) Questions





# Microcystins and Algal Toxins

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- A *harmful algal bloom* (HAB) is an algal bloom that causes negative impacts to other organisms through production of natural toxins, mechanical damage to other organisms
  - There are many different species of HAB's all which require different environmental requirements for optimal growth
  - Algal blooms are an abundant or excessive growth of algae
  - HAB's are actually cyanobacteria which is referred to as blue-green algae. These cells grow in colonies.
  - Not all algal blooms are HAB's



# What Causes HAB's To Form?

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- Excess nutrients (phosphorus or nitrogen) from agriculture, fertilizer, waste water treatment plants, leaking septic systems
- Sunlight
- Low-water or low-flow conditions
- Calm water (low wind conditions)
- Warmer Temperatures
- Low salinity
- Selective grazing by zooplankton aor zebra/quagga mussels





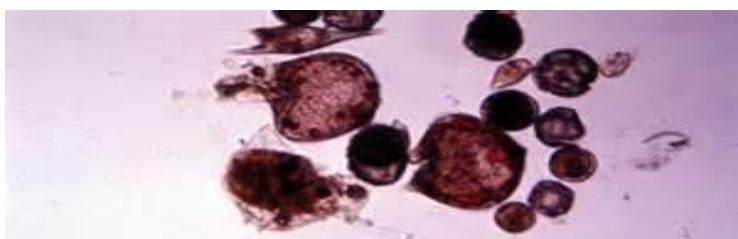
# What Do They Look Like?

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Red tide is another name for an algal bloom caused by dinoflagellates and makes the water brown or red. Usually found in coastal areas and kills manatees every year.



*Red Tide*





# What Problems Do They Cause?

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- Taste and odor problems in drinking water
- Pollution of scum on beaches
- Reduced oxygen for fish and other animals
- Problems for public water supplies
- May produce toxic chemicals
- Poison aquatic life
- Threat to human, domestic animal or livestock health







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# How Do You Test for Them?

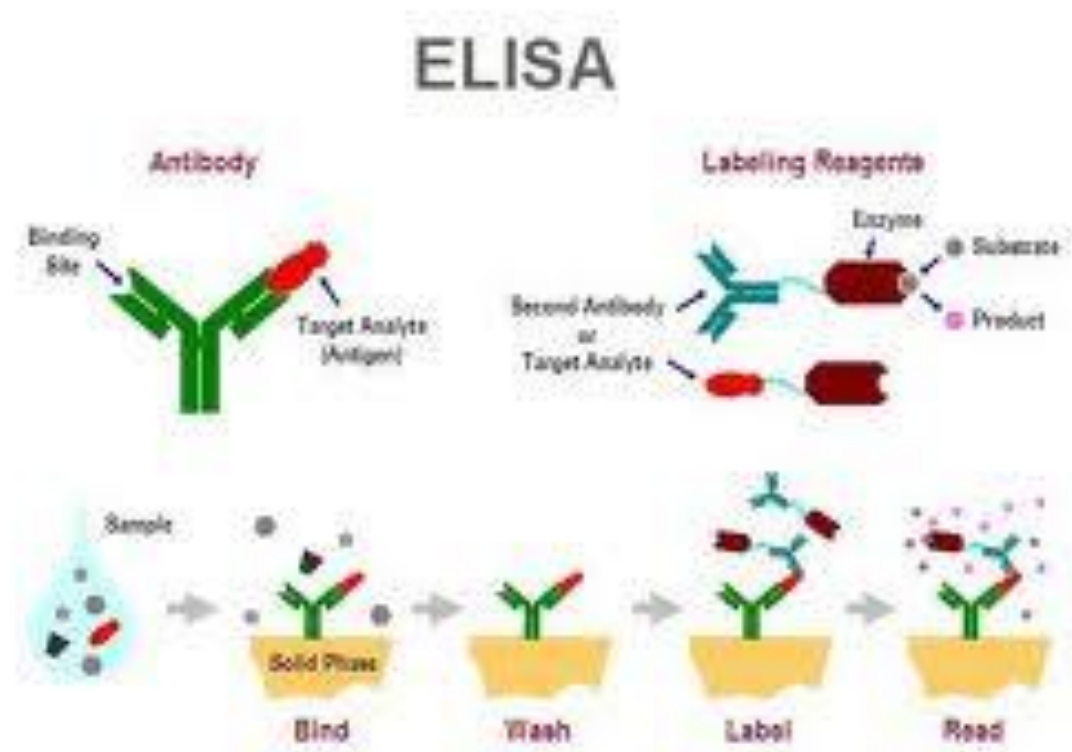
- HPLC –PDA
- Thin Layer Chrom.
- GC/MS
- LC/MS LC/MS/MS
- **ELISA**
- PPIA (Protein Phosphatase Inhibition Assay)
- Microelectrodes
- Fluorometry
- Spatial Analysis (satellite imaging)





# ELISA - defined

- common lab technique which is used to measure the concentration of an analyte (usually antibodies or antigens) in solution.
- **E**nzyme
- **L**inked
- **I**mmuno-
- **S**orbent
- **A**ssay



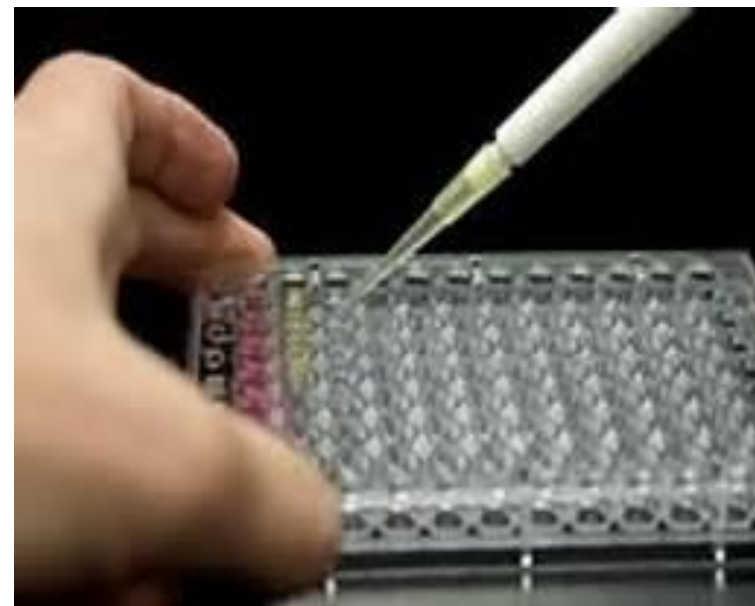


# Modern Water Test Offering

- Microcystins kits
  - Envirogard Tube Kit
  - Envirogard 96 well plate kit

## Basic Test Procedure

- Prepare standards
- Add 100 uL of sample or standard
- Incubate for 30 minutes
- Add 100 uL enzyme conjugate
- Incubate for 30 minutes
- Decant and wash five times
- Add 100 uL color solution
- Incubate for 30 minutes
- Stop the reaction and read color at 450nm





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# EnviroGard (Plate Format)

- Analytes: **Microcystins**  
Quantitative (0.1 ppb – 1.6 ppb)
- Matrix: Water
- Mode of detection: 96 Well Plate Kit
- Time to do analysis: Tests up to 88 samples – Results in 2 hours
- Equipment: Microcystins Plate Kit, Plate Reader, Disposable Pipets
- Ideal for: Source Water Monitoring





# MicroPlate Readers

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- ELISA test will also require a Micro Plate reader:
  - Thermo Fisher Scientific – available on **MSI** website
  - **Multiskan GO**
  - Microplate Spectrophotometer
- **MSI** part numbers:
  - **Multiskan GO : 51119300**
  - **EnviroGARD : 7540000**







# ATP Testing – What is it?

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## Adenosine Triphosphate (ATP)

- Molecule found in all living cells
- Reacts with the enzyme Luciferase, from fireflies, to produce light.
- More light emitted = more microbial activity
- Light emittance is quantified with a luminometer
- Intra-cellular ATP – ATP contained within living biological cells. Extra-cellular ATP – ATP located outside of biological cells that have been released from dead or stressed organisms



# The Problem

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- Several instruments give water managers the ability to quickly and easily assess several water quality parameters, such as:
  - Temperature
  - pH
  - Alkalinity
  - Turbidity
  - Color
  - TDS
- But what about biological activity? Options are very limited.





# Industry Standard - HPC

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- HPC's incubate for 24-48 hours.
- **HPC's detect only ~0.1-1% of bioburden.**
- Information is only provided on organisms that can grow...
  - ...in the media used;
  - ...at the temperature provided;
  - ...within the incubation time allowed.
- Regulatory parameters (e.g. Total Coliforms, E. Coli) measure a even smaller fraction.
- Many problem microorganisms are missed!



# The Solution

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- **Value Proposition** –A rapid, non-specific measure of total microbial content in water (or any other fluid sample).
- 3 main advantages of LuminUltra's tests:
  - 1.Real-time feedback (< 5 minutes)
  - 2.Complete results (100% of microbes detected).
  - 3.Field-ready
- Decisions can be made on-the-spot, enabling **same-shift troubleshooting.**





# Industry Overview – Drinking Water

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- **Where does ATP monitoring provide the most value in water treatment & distribution?**
  - Distribution system monitoring (nitrification);
  - Storage tank surveillance;
  - Pre-treatment (e.g. Membranes, Biologically Active Filtration)
  - Line break repairs/installations;
  - Flushing Optimization;
- **The Pain**
  - Culture tests are slow and only detect <1% of what is present.
  - Some utilities only do tests that are required by regulators (e.g. Total Coliform) which provides little or no basis for proactive control;
  - Maintenance activities that are carried out in the distribution system suffer from major inefficiencies.





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# RaPID Assay (Magnetic Particle Format)

- Analytes: **Atrazine and 2,4-D**  
Fully quantitative in ppb or low ppm
- Matrix: Soil, wipes, water, (biological material)
- Mode of detection: Magnetic particle immunoassay – compound-specific antibodies
- Time to do analysis: 2 – 3 hrs/30 samples
- Equipment: Reagent kit (specific for contaminant group), Extraction kit (for soil) RPA Analyzer, electric power source, refrigerator for kit storage





# Toxicity Early Warning System

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As defined by National Agencies worldwide:

*An ideal contamination warning system that monitors toxic events in water should have the following features*

***Rapid***

***Wide detection spectrum***

***Fit for field testing***

***User-friendly***

***Sensitive***

***Reliable***

***Continuous***

***Affordable***

**Microtox® CTM meets these requirements**



MODERNWATER

# Microtox® and Microtox® CTM



*Microtox® M500*

- Broad-band toxicity - bioluminescent bacteria (*V. fischeri*)
- Microtox® toxicity “Gold Standard” since 1980’s
- Excellent correlation with whole organism tests
- Meets regulatory requirements for effluent toxicity
- BUT is bench-top, manual system
- Microtox® CTM – first REAL TIME, CONTINUOUS on-line toxicity monitor



*Microtox® CTM*



# Microtox® CTM

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- **Acute** 'broadband' toxicity
- Instant indication of water health
  - detects unknown contaminants
- **Validated data** on >2700 chemicals – same reagent as Microtox
- As good as, or lower levels of detection than other biosensor systems
- Microtox is widely accepted in water industry as indicator of human toxicity
- Works in chlorinated water and high Total Suspended Solids (TSS)





# Microtox® CTM operating features

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- 4 weeks fully automatic operation cycle
- Large data set – 1 data point/ 2 sec
- Fast response - 2 minutes delay
- Wide T range - 5-30°C (40°C)
- Auto response validation
- Self-diagnosis of system faults
- Automatic cleaning
- Low operator skill level
- Low maintenance ~ 2 h/month







# Levels of detection

Toxin	Concentration (ppm)	Detection Level	
		2 min	7 min
DMSO	10,000	1	2
Mercury Chloride	0.1	2	<b>4</b>
Potassium Cyanide	2.5	<b>3</b>	2
Glyphosate	0.5	<b>3</b>	<b>3</b>
Atrazine	0.1	<b>3</b>	<b>3</b>
Phenol	20	<b>3</b>	<b>3</b>
Zinc Sulphate	5	<b>3</b>	<b>4</b>
Sodium Nitrite	0.1	<b>3</b>	<b>4</b>
Sodium Arsenite	0.1	<b>3</b>	<b>5</b>
Toluene	0.1	<b>4</b>	<b>3</b>
Malathion	0.1	<b>4</b>	<b>4</b>
Potassium Dichromate	0.1	<b>4</b>	<b>4</b>
Chromium (IV) Oxide	25	<b>5</b>	2

1 : No detection  
2 : <10% inhibition  
**3 : 10-25% inhibition**  
**4: 25-50% inhibition**  
**5: >50% inhibition.**



# Markets for CTM

**Drinking  
water intake**



**Industrial  
discharges/ recycling**



**High security  
Buildings/ distribution**



**Oil well  
discharges**



**Potential Terrorist  
targets**



**Algal  
toxins**



Fresh, saline, chlorinated and waste waters



# Microtox® CTM market drivers

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- Environmental
  - Characterization of water source quality
  - Monitoring improvement measures
- Regulatory
  - Specific toxicity testing legislation
  - Legislation on water Q.A.
- Security/ Early Warning System
  - Deliberate contamination
  - Industrial pollution
  - Natural events
- Economics
  - Cost of monitoring/ manpower





# CTM installations

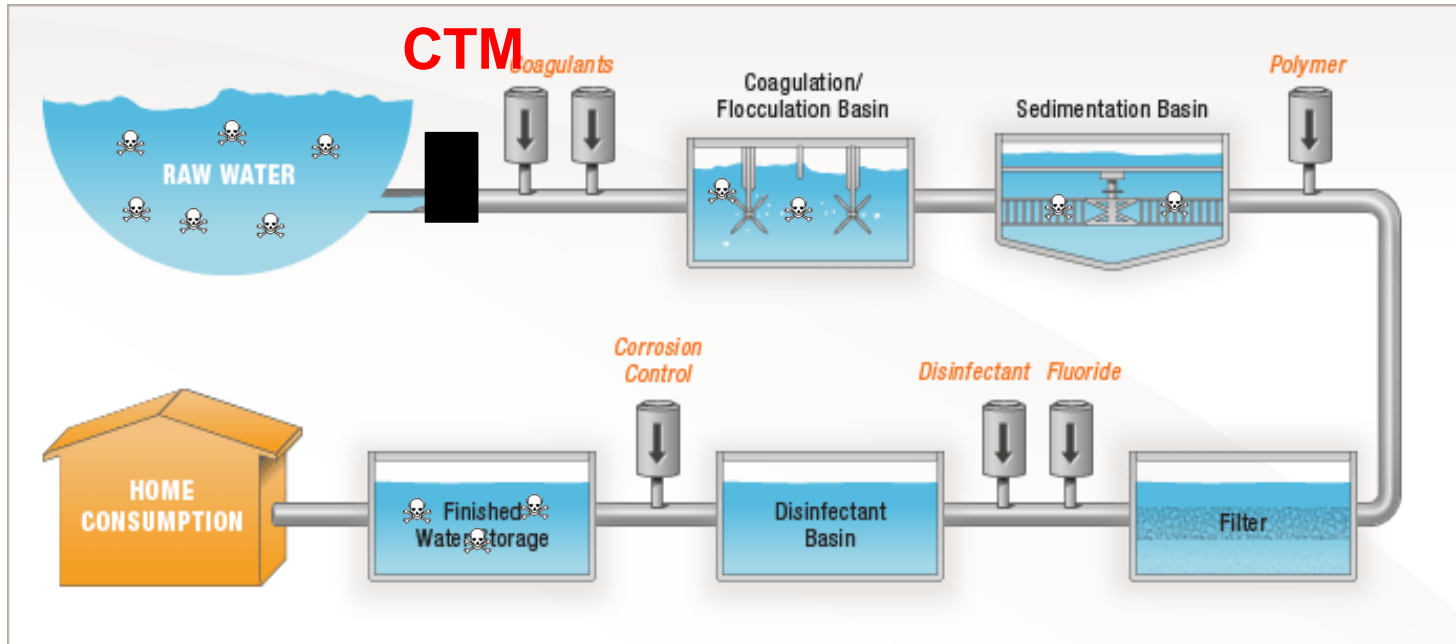
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- AquaAmerica, Delaware, United States – Drinking Water Protection
- Anglian Water, Norfolk, UK – Drinking Water Protection
- KECO (Korea Environmental Corporation) South Korea – Drinking Water Protection
- Huntsville WPC, Alabama – Waste Water Pre-treatment Monitoring





# Drinking water intake protection



CTM monitors at intake to plant

- Alarms
- Automatic stop of intake

=> Drinking water protection for thousands of people







## Drinking water – West Virginia chemical spill

- 10 Jan 2014: Foaming agent used in the coal industry leaked from a 48,000-gallon tank at Freedom Industries
- Contained 4-methylcyclohexane methanol
- 300,000 residents were told not to bathe, brush teeth or wash clothes in tap water
- West Virginia American Water DWTP closed its intake – but not until water already in distribution
- Had to flush out entire distribution system
- The spill brought West Virginia's most populous city and nearby areas to a standstill, closing schools and offices and even forcing the Legislature to cancel its business for the day.







# Drinking water – West Virg. chemical spill (Jan 2014) MODERNWATER



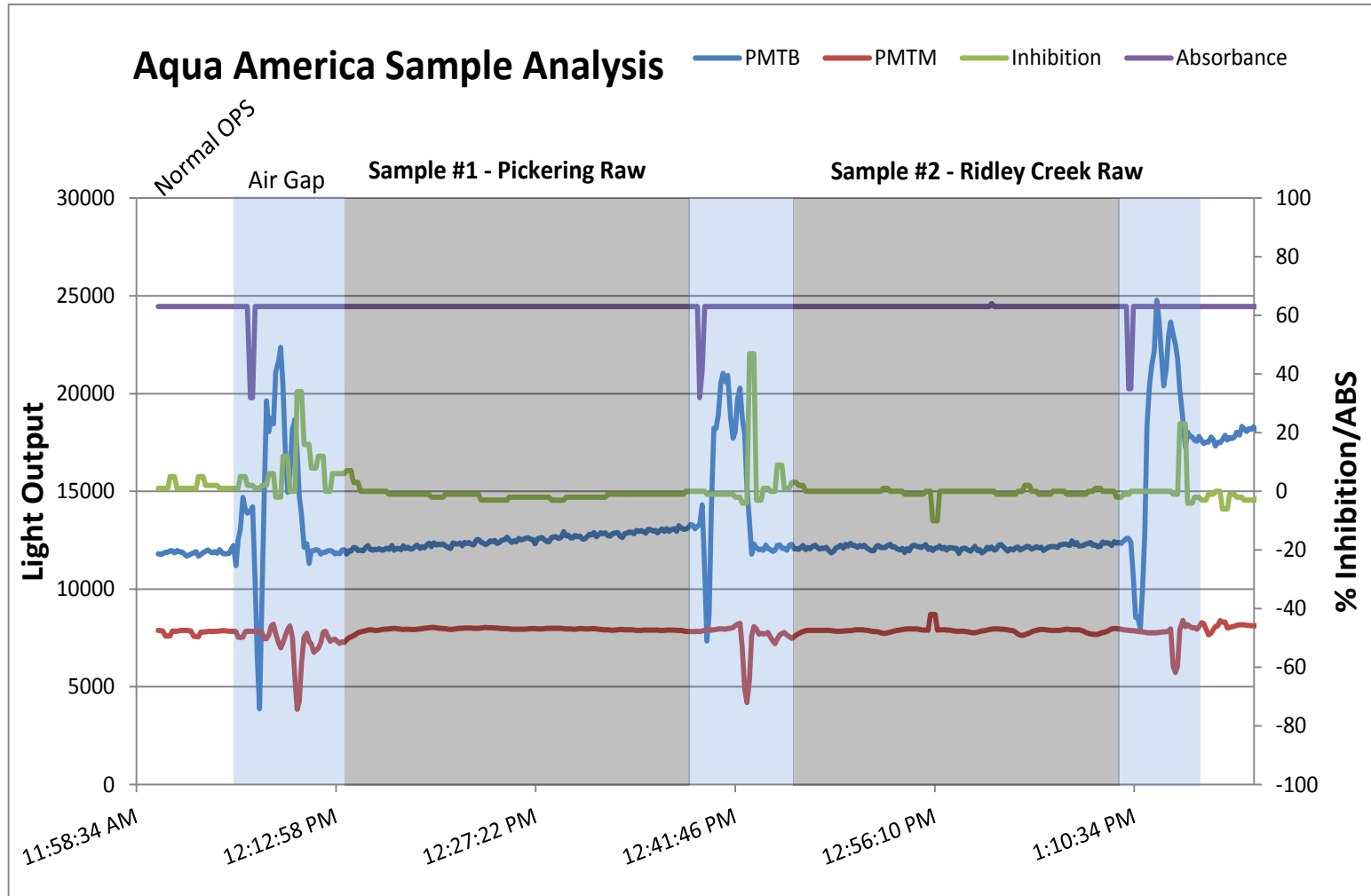
- Incident lead to increased focus on risk from chemical accidents with unknown chemicals => need for toxicity monitoring  
AquaAmerica decided to start a trial with CTM
- American Water (who runs TP in West Virginia) has a very strong interest



# AquaAmerica, USA

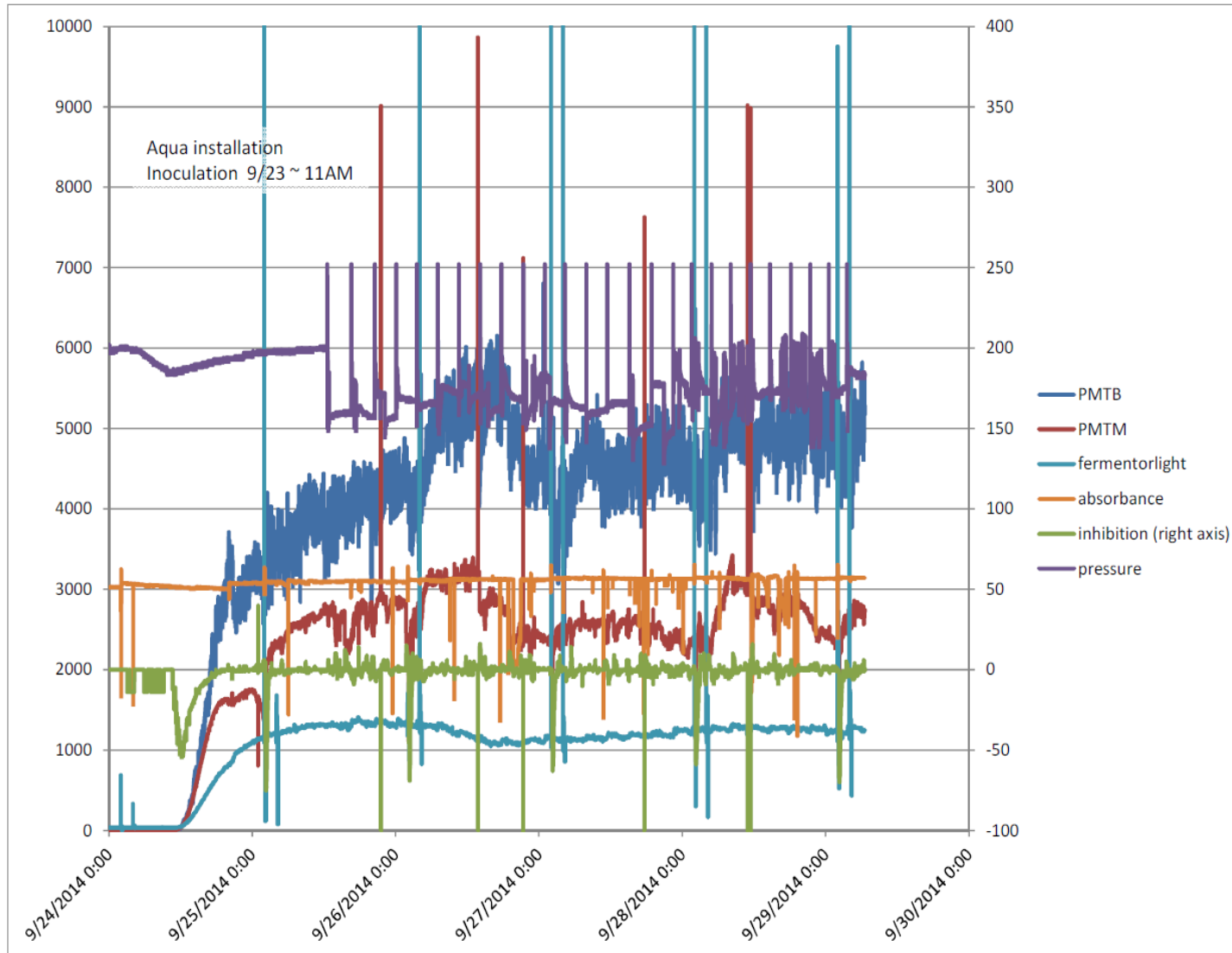


# AquaAmerica Sample Pre-test Data





# AquaAmerica Installation

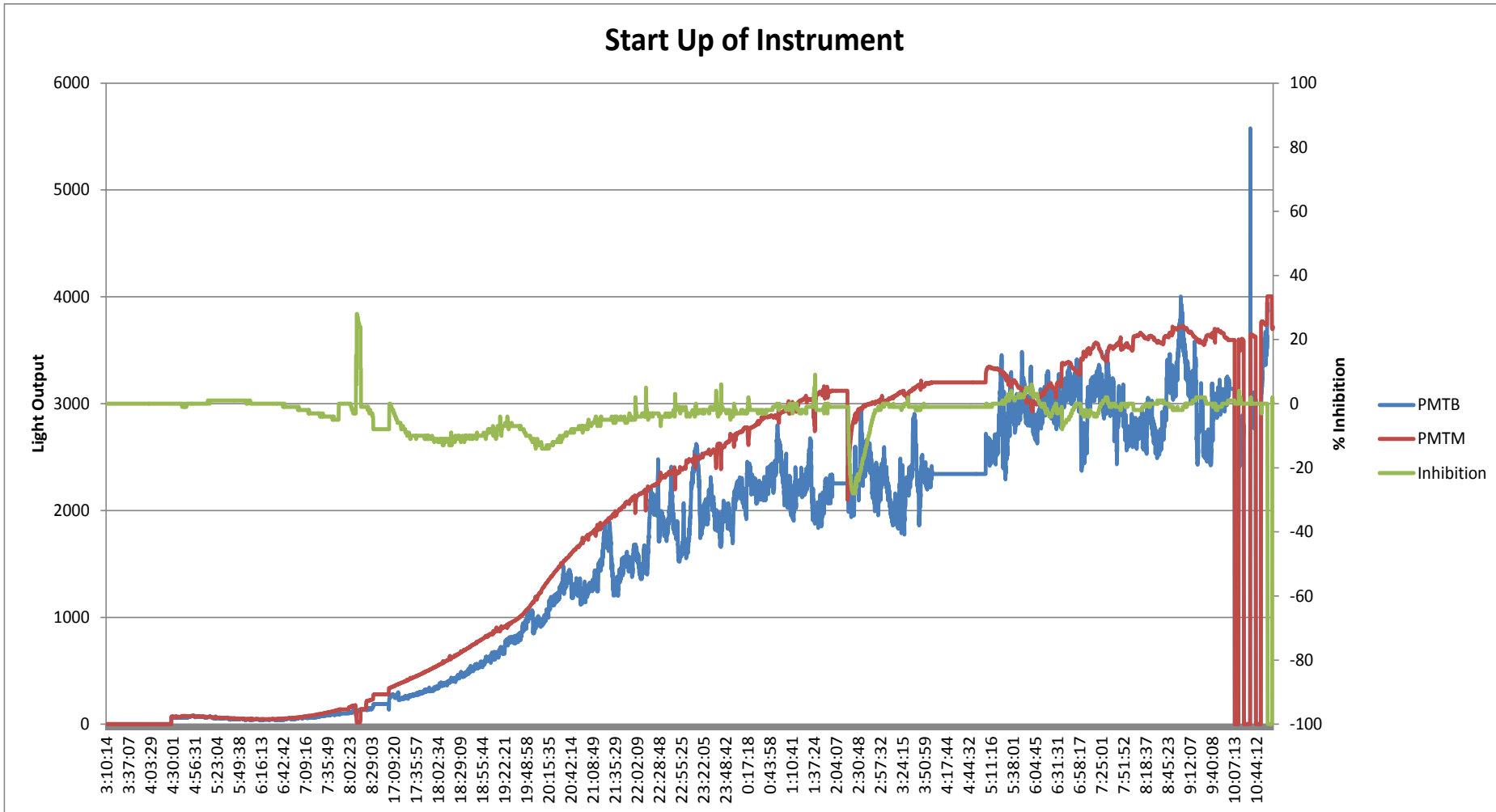




# Stokes Ferry, Anglian Water



# Anglian Water Example Data





# South Korea, KECO





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- **Questions?**

- Mark Fashian
- Covenant Analytical Solutions
- Delaware, Ohio
- Mark@covenantanalytical.com
- 740-936-0045

- **Thank You.**