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New Insights and Technologies for
Treatment Process Optimization

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Webinar
moderator
Billie Emas
is a Sales Associate at the American Water Works Association.
Billie Emas is the Sales Associate to the NE and SE territories in the Sales Department at AWWA. She has been with AWWA for six months and she has been corresponding and building relationships with the members, advertisers, exhibitors and sponsors with AWWA. She has over 20 years of experience marketing, sales, event planning and membership. Billie has a BS in Business Administration from Bowling Green State University.
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Presenters
Derek Walker
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Applications Development Manager
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Guest Speakers
David G. Miller, P.E.
Deputy Director, Water Supply
Manchester Water Works
Jana Safarik
Principal Scientist at Orange County Water District
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Learning Objectives & Webinar Description

Changing or unreliable source waters are presenting more challenges for already strained Water Professionals; especially when it comes to understanding how to adjust your treatment process. Join to hear how leading WTPs are optimizing their processes, meeting water supply management requirements, and allowing their staff to focus on the most important work by switching some monitoring solutions from lab to process technologies.

Attendees will:

Learn new ways to improve treatment, plant operations and water quality.

Identify areas of opportunity based on colleagues and industry experts experience using new tools and technology now available.

Ask questions during live question and answer session and learn from the presenters during the session.

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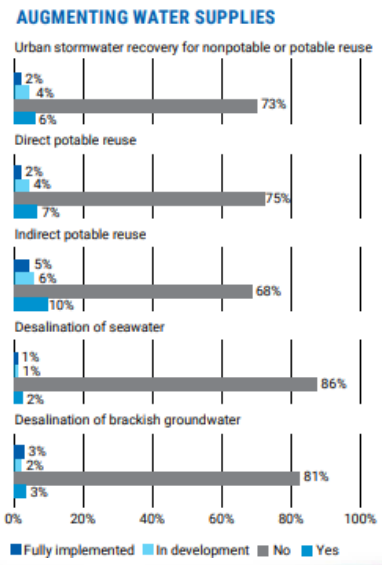
1 Source Water Scarcity



Source: AWWA 2019 State of the Water Industry Report

58%

do not have a fully-developed drought management or water shortage contingency plan.

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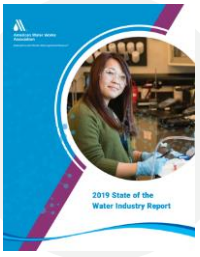
2 Limited personnel and employees



State of the Water Industry Report

Unprompted Responses

Education

"We don't have the qualified candidates and it takes multiple years to create a qualified candidate. Without the qualified workforce, we will acquire fines and citations for regulatory compliance and we put ourselves at high risk."

Workforce

"Attracting & preparing adequate number of candidates for the thousands of STEM [science, technology, engineering, and math] & Mid-Skills job vacancies. We need to do a much better job of recruiting & retaining the TOP talent that this industry needs."

Stakeholder Engagement and Communication

"The industry needs to communicate better with the public to assist in restoring their trust in public water utilities following the Flint and other water quality crises."

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Dramatic change in landscape, new regulations and new things we never thought we had to consider

The COVID-19 crisis is expected to result in a marked reduction in water and wastewater project activity in North America in 2020.

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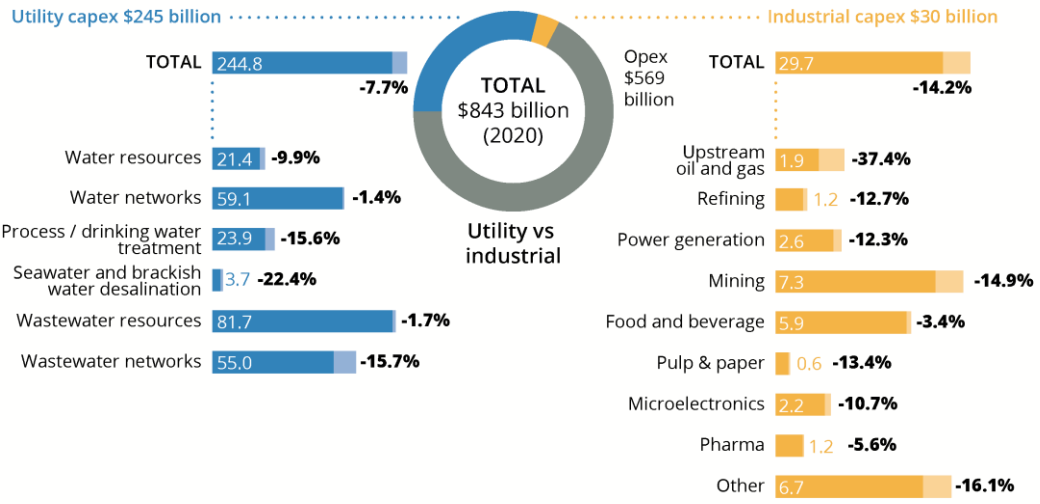

Source: GWI Data – COVID-19 April 2020 Forecast Outlook

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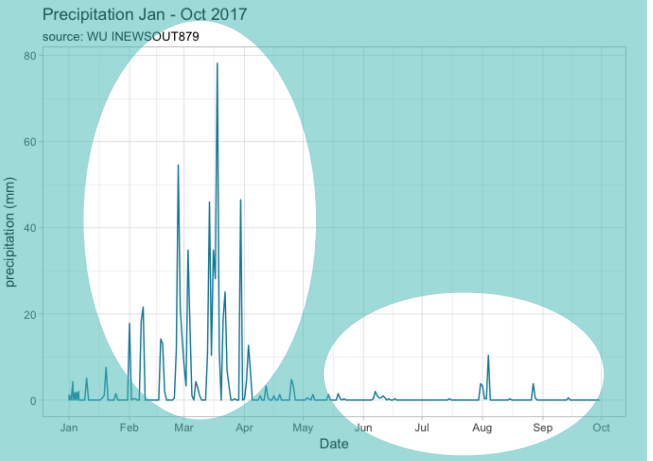
More Data = More Visibility in a Changing landscape

- Aging infrastructure, both in-plant and in distribution, requires more attention
- Periodic grab sampling may not be sufficient to monitor pipes and processes from source to tap
- Online monitoring provides the backdrop of a continuous data stream that allows operators and plant managers to detect an excursion from *normal* much more rapidly



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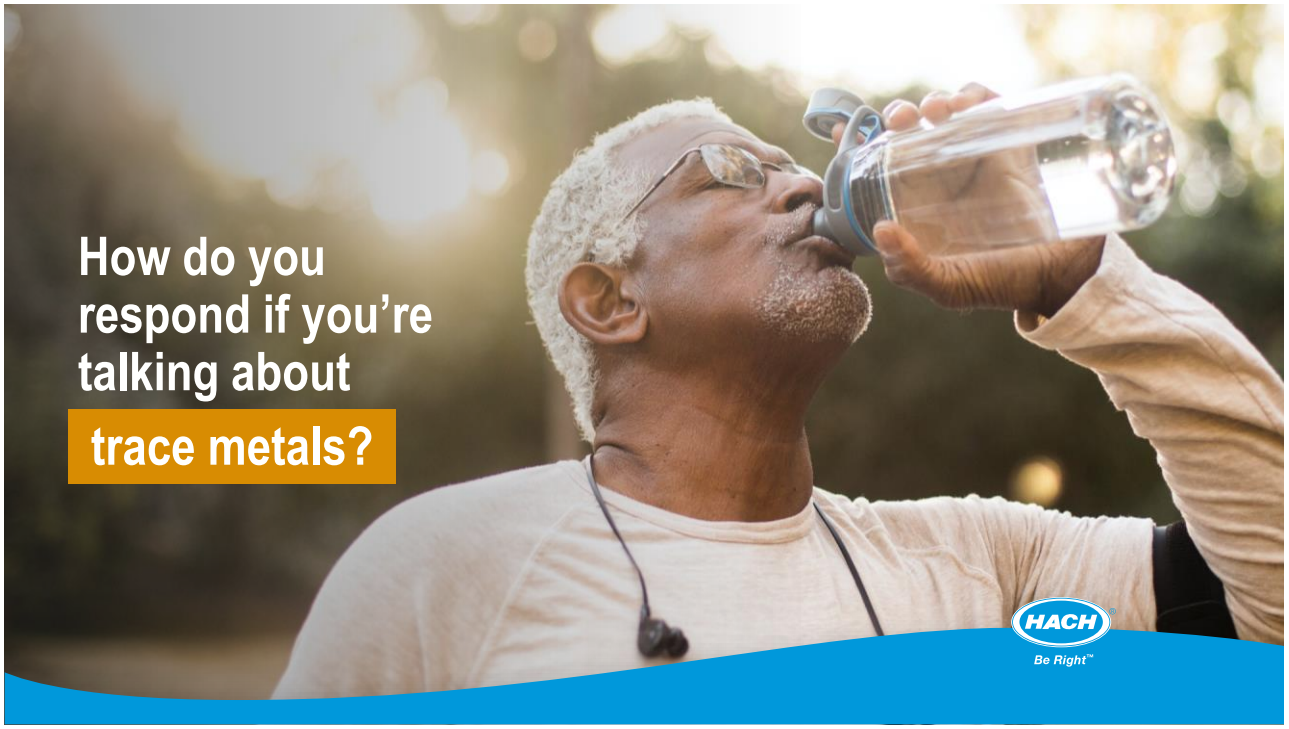
How do you respond if you're talking about
trace metals?
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What does this response look like if you're talking about
microbial content?
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Conventional Micro Testing

Traditional bacterial tests consist of HPCs or coliform tests in the distribution system

These incubation-based methods are limited or influenced by various factors:

- Sampling frequency (contaminations between samplings is not detected)
- Species selective culture media (higher costs)
- Cultivability of different bacteria (0.1 - 1% of all bacterial species)
- Availability and accuracy of laboratory personnel

Sampling time + incubation time + handling time

= slow response time

If a more rapid method were available, where else could you test?

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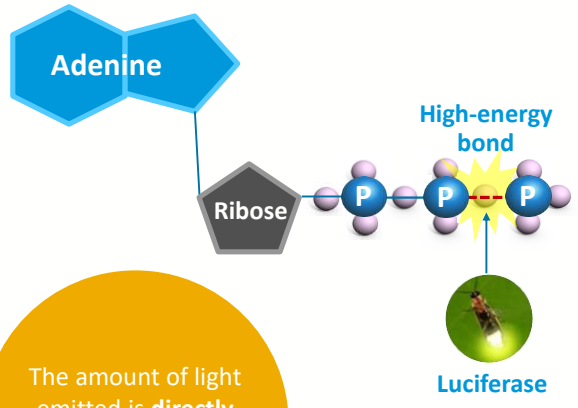

The amount of light emitted is **directly proportional to the amount of ATP**

Adenosine Triphosphate (ATP)

Provides energy to living cells - "Molecular Unit of Currency" of intracellular energy transfer

Classified as a nucleoside triphosphate

- ✓ Nitrogenous base (adenine)
- ✓ Ribose sugar
- ✓ Triphosphate

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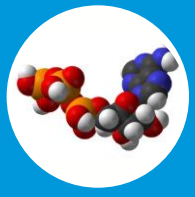
ATP Chemiluminescence Reaction

ATP assays using luciferin/luciferase reactions allow to assess microbial activity in water sources. The **ASTM D4012 (Standard Test Method for Adenosine Triphosphate Content of Microorganisms in Water)** was developed as a quick and sensitive alternative to plate counting.

Higher ATP content



Higher light output

Higher bacterial load

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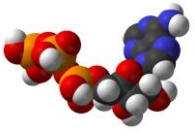
Cell dies and ATP is rapidly degraded

ATP serves as a reliable biomarker for living organisms in a sample

ATP can be used as a parameter in high-frequency, automatic, on-line microbial analysis in water

Things to know about measuring ATP

Online options to measure Free ATP, Total ATP and Intracellular ATP



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Most are likely testing using Manual testing

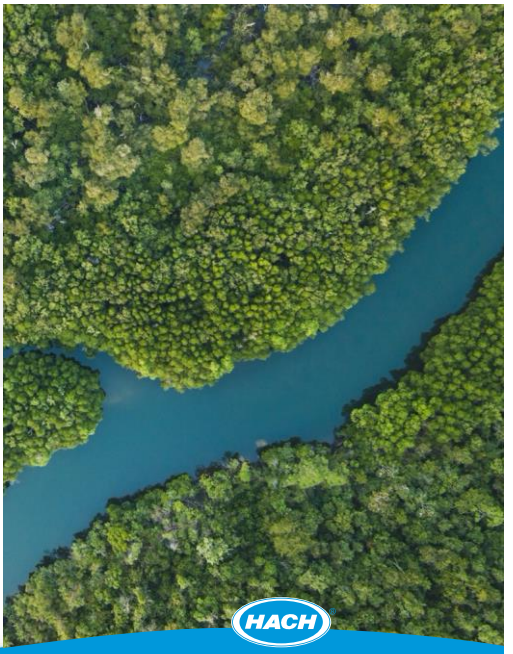
Detection of bacterial contamination by means of ATP assays has been done for several years. Today, many brands of manual test kits are available on the market.

Disadvantages:

- Usually low sampling frequency
- High labor intensity
- Specialized labor to complete with reliability and highly trained
- No operator free digital record

Advantages:

- Very fast results (few minutes)
- Signal reflects total bacterial content



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Disadvantages:

- Usually low sampling frequency
- High labor intensity
- Specialized labor to complete with reliability and highly trained
- No operator free digital record

Advantages:

- Very fast results (few minutes)
- Signal reflects total bacterial content

But a more rapid biological method could enable testing in…

- Filter monitoring and biofiltration
- Effectiveness of RO and ultrafiltration
- Direct Potable and Indirect Potable reuse
- Tank Monitoring
- Distribution monitoring and chloramination

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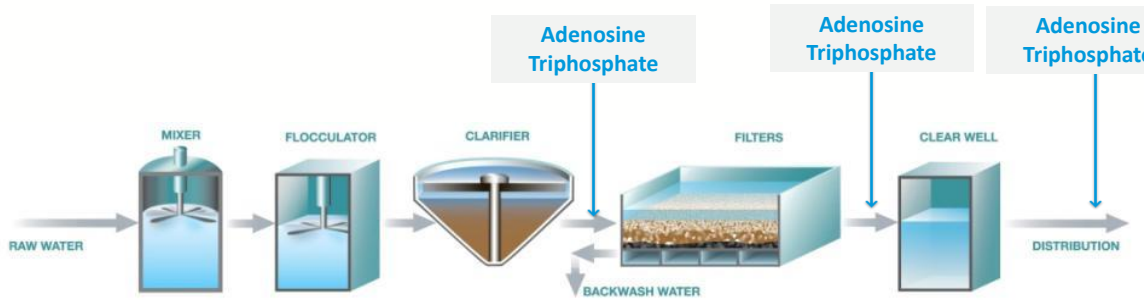
Main areas for monitoring ATP



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Filtration

- Biofiltration monitoring
- Bacteria growth on the sand filters
- Membrane fouling control

ATP

EZ7300 ATP

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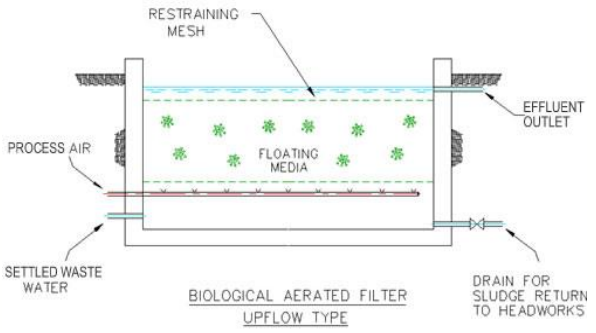
Optimization of a biological filter and plant risk mitigation

The Objectives

- Monitor in real time the microbial activity of the influent and effluent of their biological filter.
- Determine the efficiency of the biological filter in removing biomass (microbial activity)
- Trouble shoot/mitigate risk in other parts of the plant using the grab sample line of the analyzer
- Demonstrate log removal



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Disinfection & Clear Well

- Monitoring and optimization of disinfection treatments steps
- Efficiency of the disinfection process check
- Contact Time in the Clear Well

Adenosine Triphosphate

EZ7300 ATP

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Distribution Network
EZ7300 ATP
Adenosine Triphosphate
DISTRIBUTION
Monitoring of the bacteria regrowth in the distribution network
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Managing water supplies with
conservation and innovation
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Adenosine Triphosphate as an Online Surrogate to Monitor Reverse Osmosis Performance and Integrity in Reuse Applications
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ORANGE COUNTY WATER DISTRICT
Trussell
TECHNOLOGIES INC
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Agenda
Background
Project goals and benefits
ATP as a surrogate
Results
Conclusions
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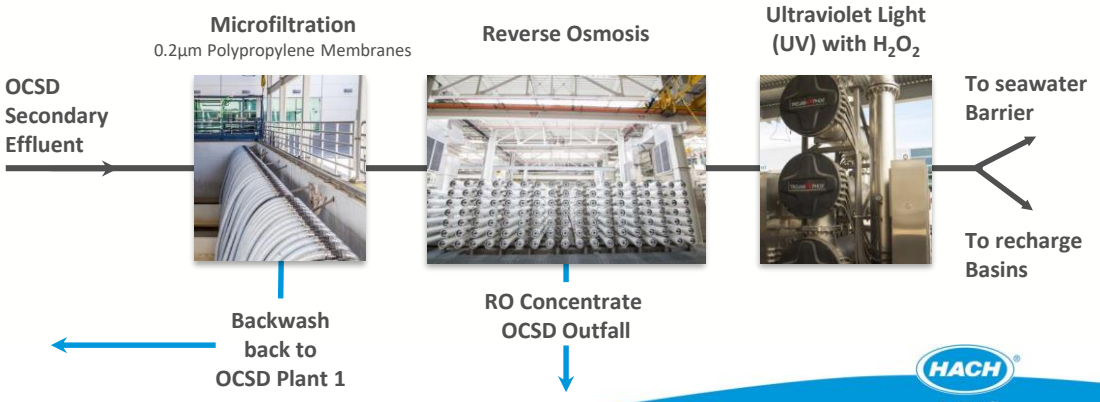
OCWD Groundwater Replenishment System (GWRS)

Largest potable reuse facility in the world,
producing 100 mgd of high purity water



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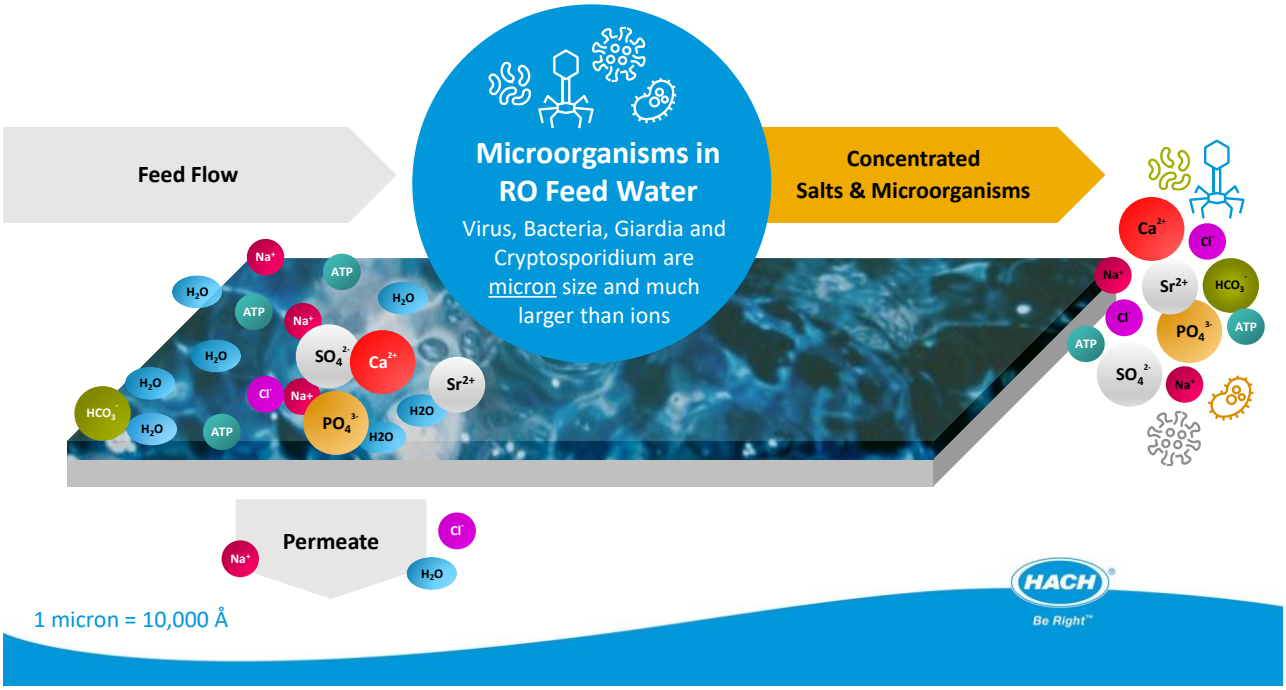

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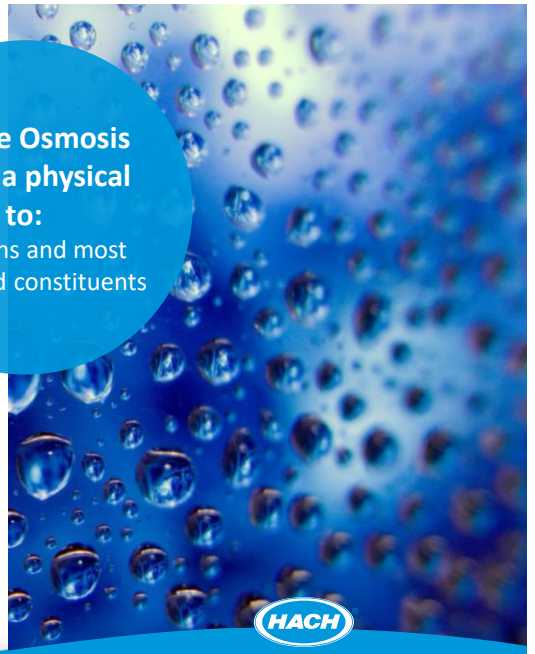
Background

Reverse Osmosis (RO) is a physical barrier to:
Pathogens and most dissolved constituents



Pathogen removal credit depends on continuous integrity monitoring of surrogates for virus rejection

Surrogates demonstrate 1 – 2 logs of removal credit
Conductivity - up to 1.5 logs of removal credit
Total organic carbon (TOC) - up to 2 logs of removal credit

Virus spike studies have shown up to 6 logs of virus removal
New surrogates are necessary

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Project Goals and Benefits

GOALS

- Identify better, realistic surrogates for use in monitoring RO performance for reuse
- Achieve higher log removal credits than conductivity and TOC

BENEFITS

- Increasing confidence, from both the industry and public, in RO's ability to remove high levels of pathogens
- Reducing the burden of pathogen removal credits on the rest of the treatment train

VIRUS LOG REDUCTION CREDITS FOR GWRS

Pathogen	Minimum Log Reduction Requirements	OCSD Plant 1	MF and Chlorine	RO	UV/AOP	Underground Retention Time	Total
Viruses	12	0	0	2	6	4	12

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Criteria for a Successful Surrogate

- Measurable permeate concentrations
- The surrogate needs to demonstrate a log removal value that is less than actual virus log removals, to protect public health
- Cost effective
- Reliable online monitor
  - ✓ Currently, not all promising surrogates have associated online monitors
  - ✓ Grab samples and same day analysis may be a viable alternative

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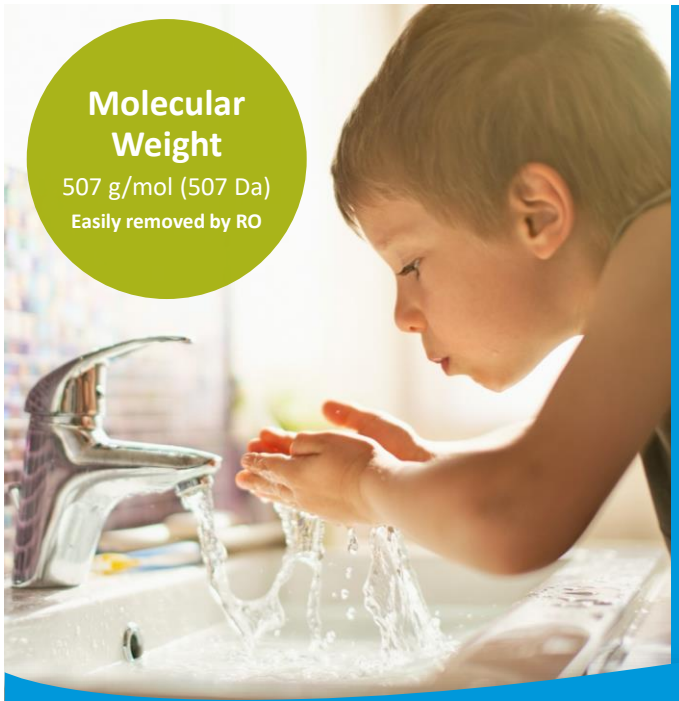

Molecular Weight
507 g/mol (507 Da)
Easily removed by RO

ATP as a Surrogate for RO Integrity

Present in waste water as:

- ✓ Cellular ATP
  - Contained within living cells
  - Indication of total living biomass quantity
- ✓ Extracellular or free ATP
  - Is the portion of ATP released by dead cells

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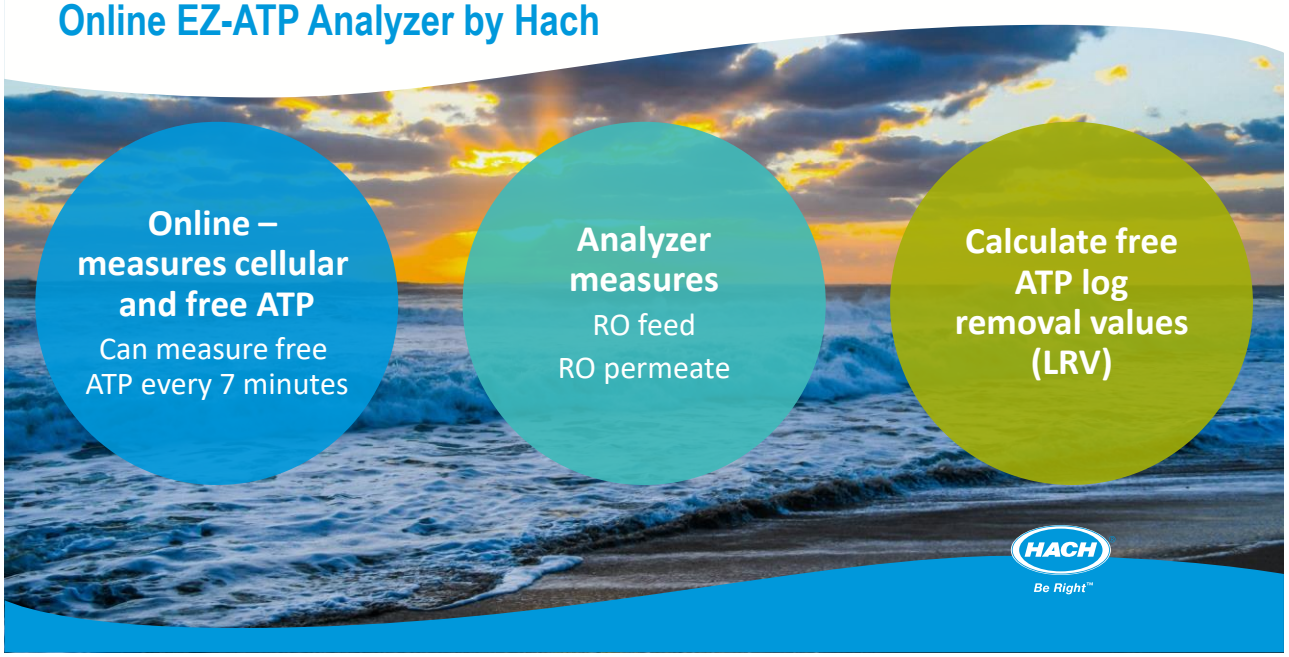
Online EZ-ATP Analyzer by Hach



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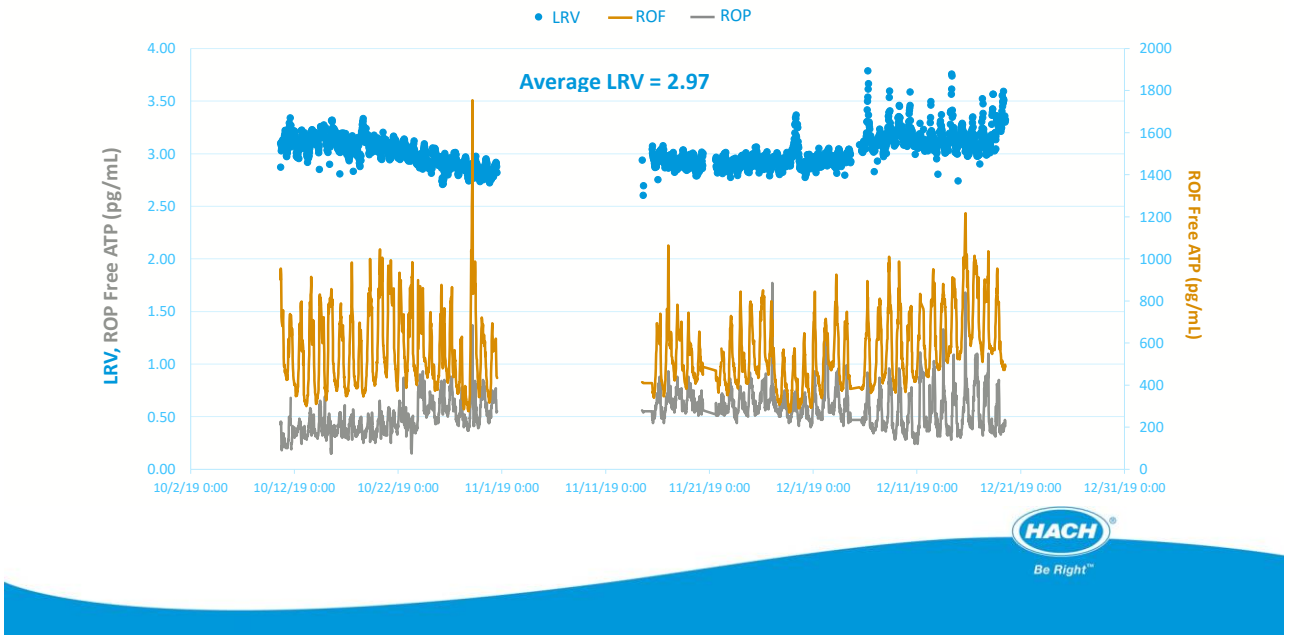
Free ATP



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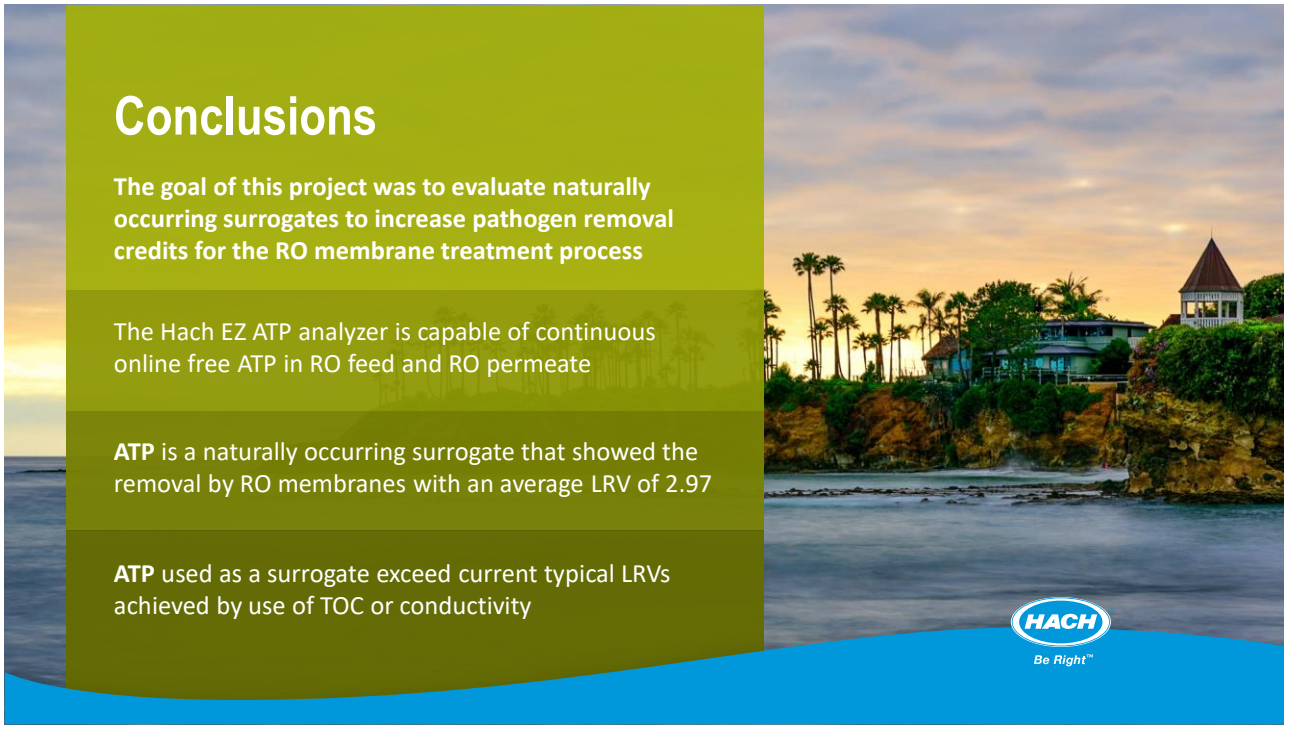
Conclusions
The goal of this project was to evaluate naturally occurring surrogates to increase pathogen removal credits for the RO membrane treatment process
The Hach EZ ATP analyzer is capable of continuous online free ATP in RO feed and RO permeate
ATP is a naturally occurring surrogate that showed the removal by RO membranes with an average LRV of 2.97
ATP used as a surrogate exceed current typical LRVs achieved by use of TOC or conductivity
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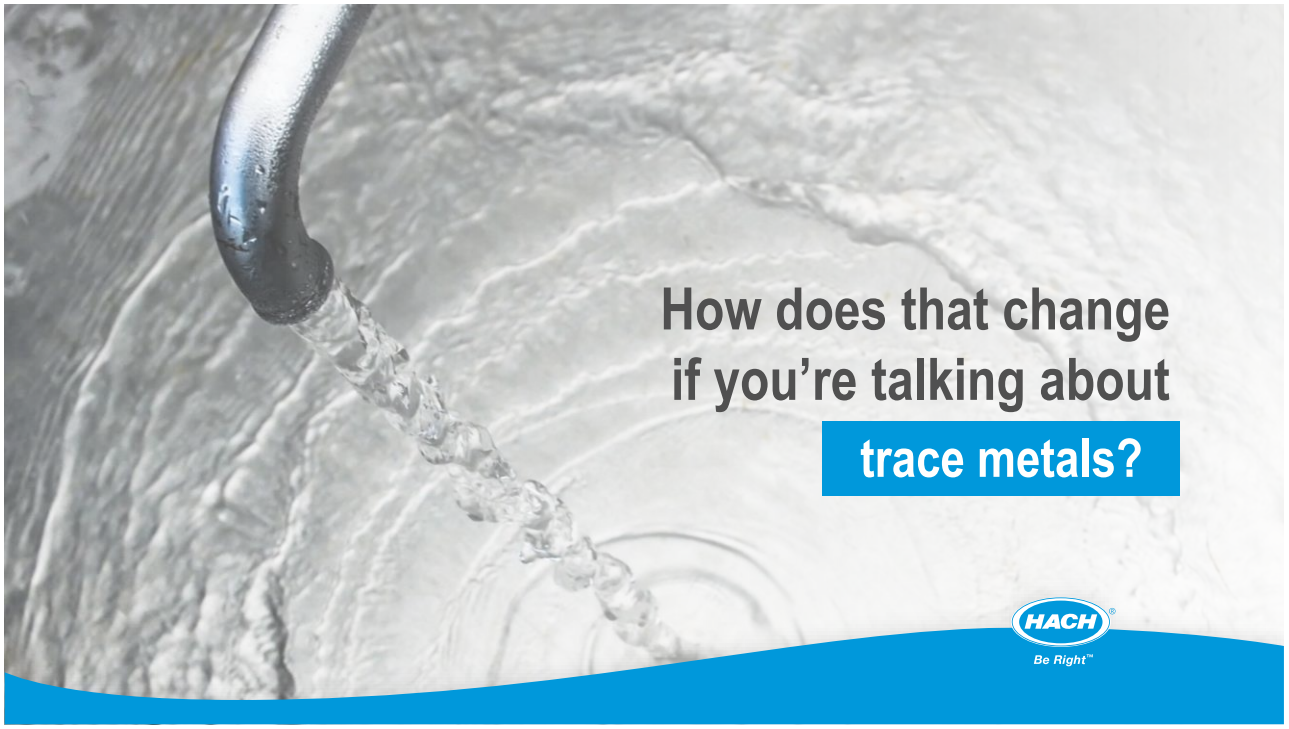
How does that change if you're talking about
trace metals?
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Manganese Removal

Treating manganese with an oxidant converts it from its dissolved (reduced) form, and changes it to its insoluble (oxidized) form to create a precipitate

Mn^{+2} (reduced)→**Mn^{+4}** (oxidized)

Different oxidants can be used:

Potassium Permanganate ($KMnO_4$)

$3Mn^{+2} + 2KMnO_4 + 2H_2O \rightarrow 5MnO_2 + 2K^+ + 4H$

Chlorine (Cl_2)
Ozone (O_3)
Chlorine Dioxide (ClO_2)
Oxygen

Oxidant dose is typically set using grab samples

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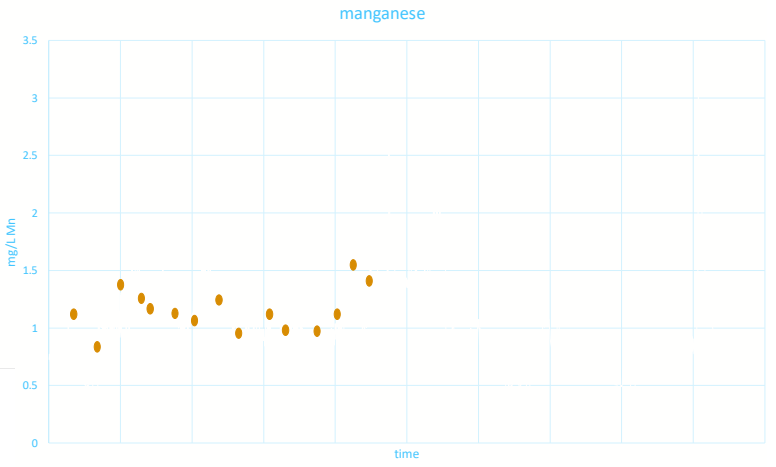
Manganese Monitoring

Grab samples



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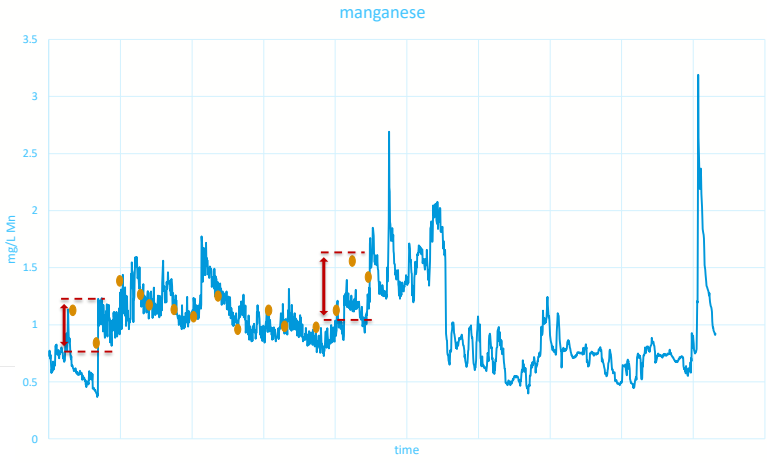
Continuous Monitoring of Manganese

Grab samples + Continuous Monitoring



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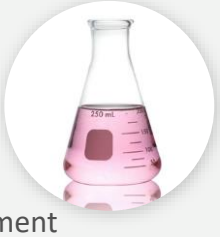
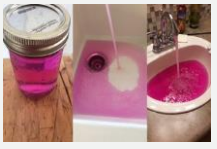
Manganese Monitoring
Risk of Overdosing vs Underdosing

Oxidant Overdosing
can cost extra money without any improvement in treatment



In some more extreme cases…



Underdosing Oxidant
can cause dissolved Mn to pass through filters and enter the distribution system

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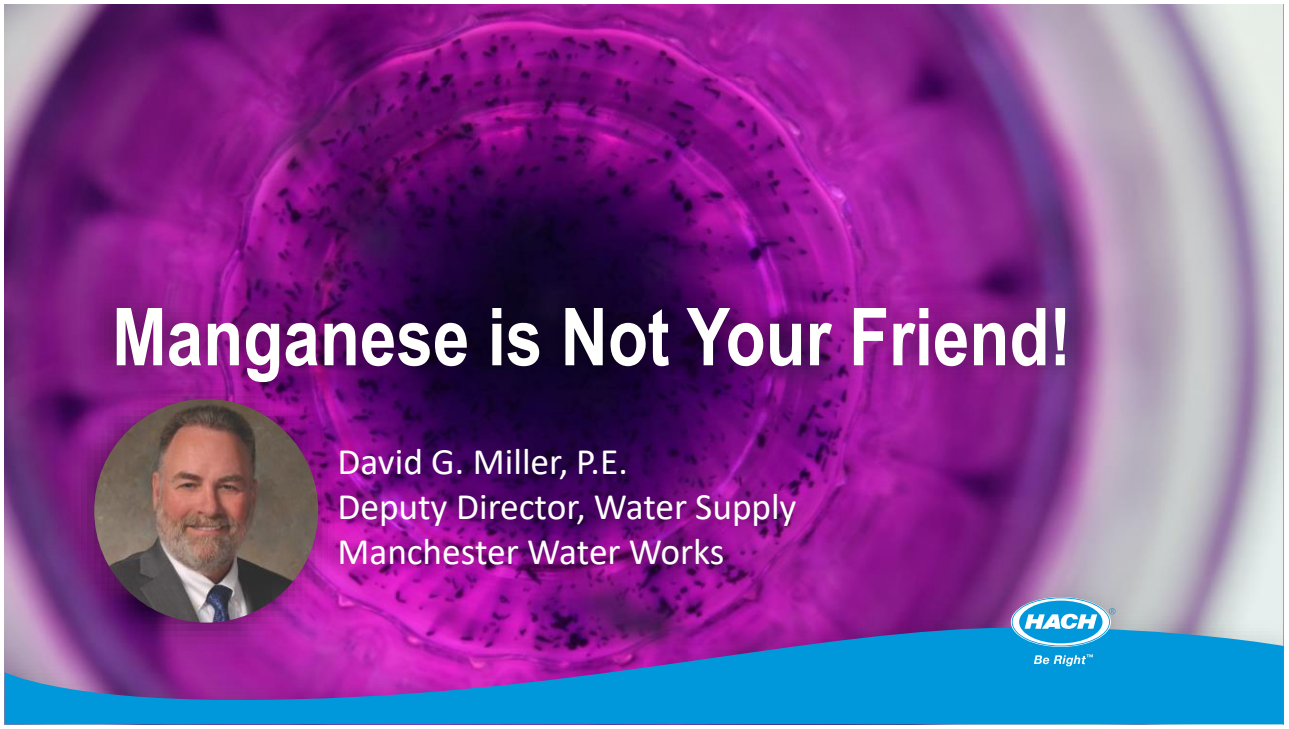
Manganese is Not Your Friend!
David G. Miller, P.E.
Deputy Director, Water Supply
Manchester Water Works
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Sole Source:
Lake Massabesic
2,500 acres
soft, mildly corrosive, low alkalinity
160,000
Serves a population of Manchester, NH and six surrounding towns
18/32.3 MGD
Average day/Max day (July, 2010)
33-80°F
Lake Massabesic temperature range
10-50
Lake Massabesic color range
3.0-6.0
Lake Massabesic TOC
MANCHESTER WATER WORKS
MWW
ESTABLISHED JUNE 1871
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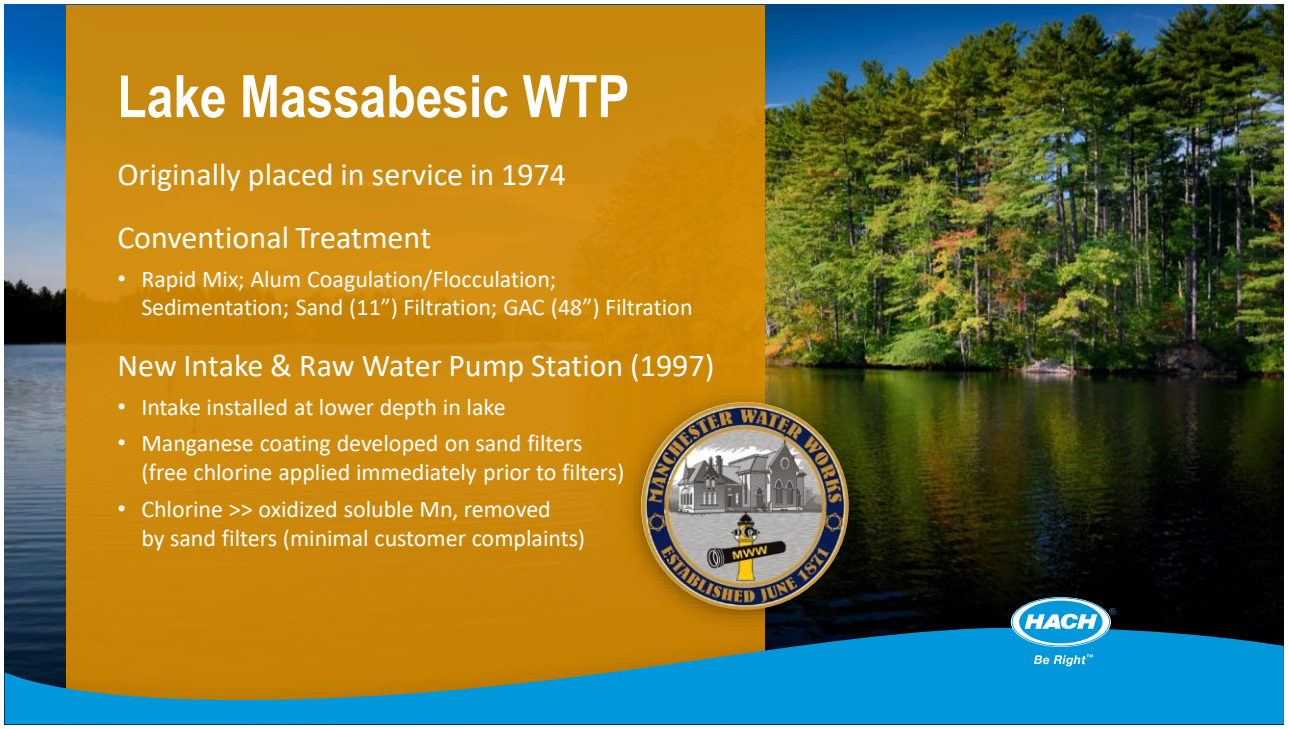
Lake Massabesic WTP
Originally placed in service in 1974
Conventional Treatment
• Rapid Mix; Alum Coagulation/Flocculation; Sedimentation; Sand (11") Filtration; GAC (48") Filtration
New Intake & Raw Water Pump Station (1997)
• Intake installed at lower depth in lake
• Manganese coating developed on sand filters (free chlorine applied immediately prior to filters)
• Chlorine >> oxidized soluble Mn, removed by sand filters (minimal customer complaints)
MANCHESTER WATER WORKS
ESTABLISHED JUNE 1871
MWW
HACH
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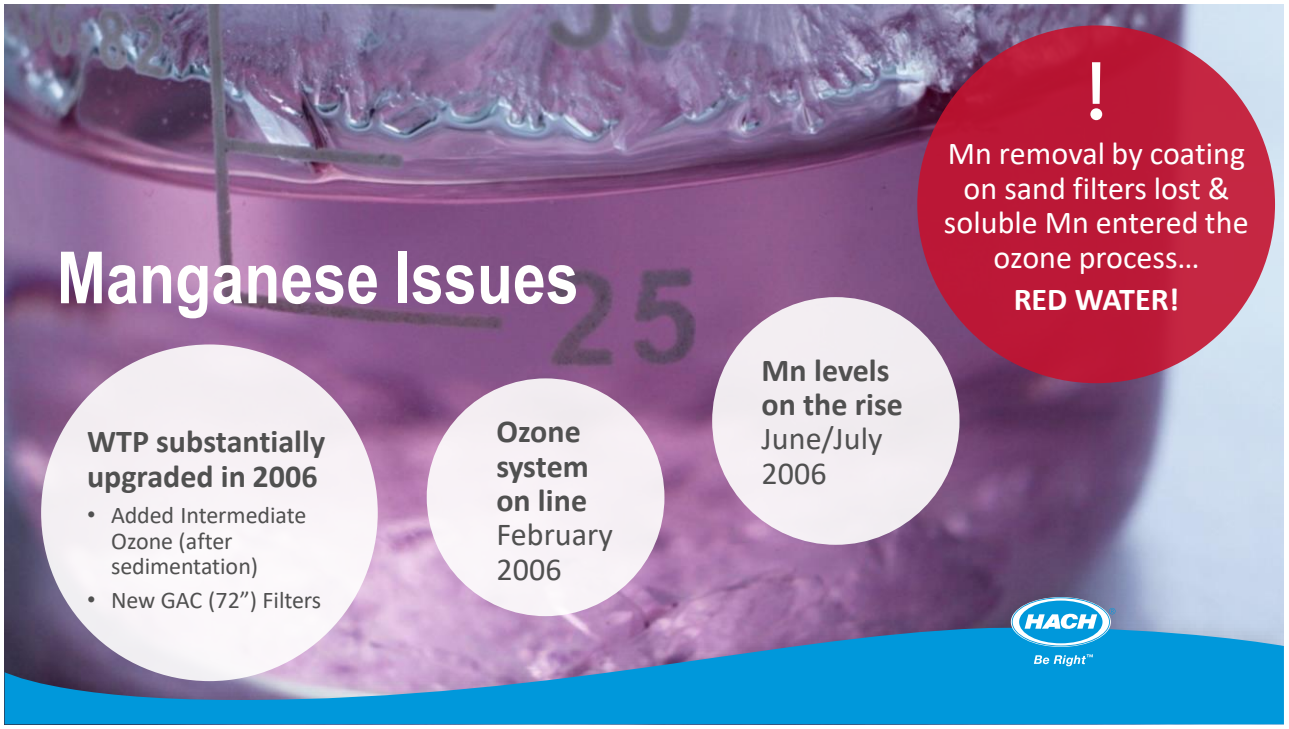
Manganese Issues
!
Mn removal by coating on sand filters lost & soluble Mn entered the ozone process…
RED WATER!
WTP substantially upgraded in 2006
• Added Intermediate Ozone (after sedimentation)
• New GAC (72") Filters
Ozone system on line February 2006
Mn levels on the rise June/July 2006
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Problem Solved?
Submerged curtain wall
was installed around the intake screens in 2007
Lake stratification
leads to anoxic conditions near lake bottom (intake screen location) reducing insoluble to soluble Mn
Oxygenated surface water
directed into intake cutting off flow of soluble Mn into WTP
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Problem NOT Solved!
In August 2009, MWW again experienced a significant Mn episode
Discovered soluble Mn was distributed throughout the water column rendering the curtain ineffective
!
POE Mn ≈ 0.09 mg/L, customer complaints numerous "yellow/brownish water"
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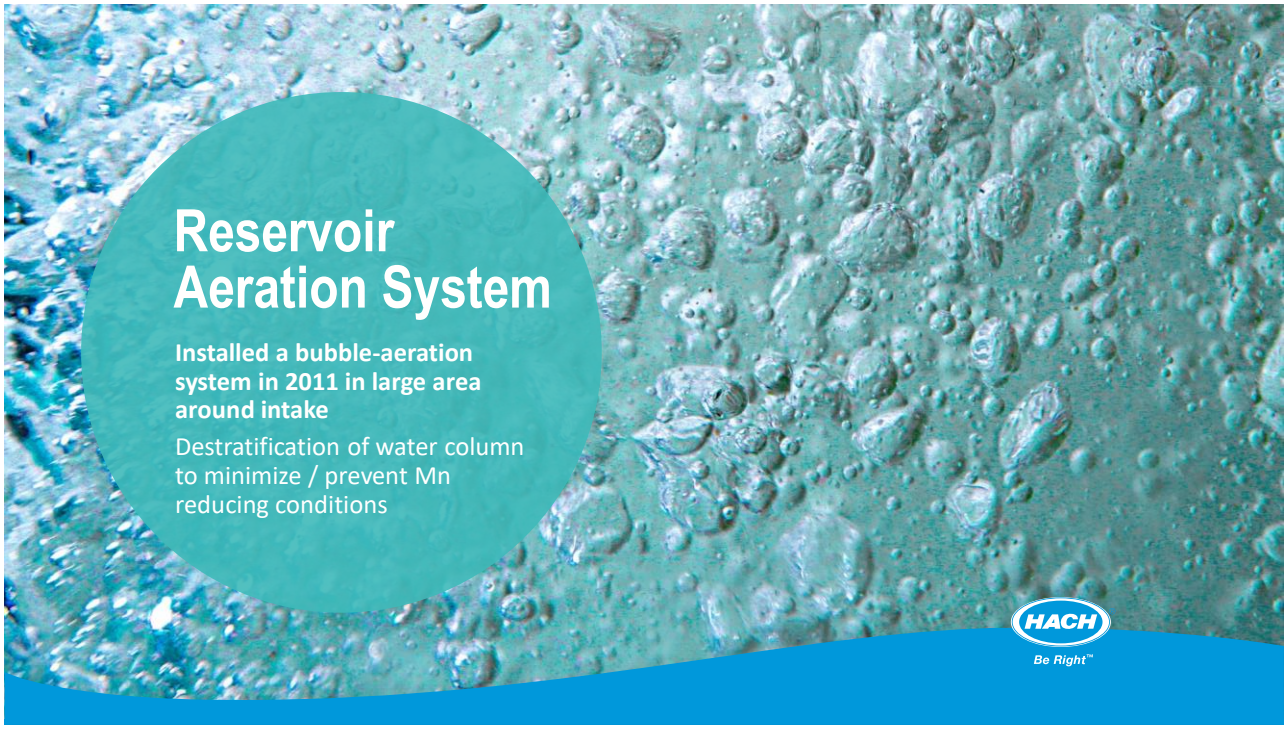
Reservoir Aeration System
Installed a bubble-aeration system in 2011 in large area around intake
Destratification of water column to minimize / prevent Mn reducing conditions
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Thanksgiving 2018
8.75" of rain in November
(record since 1895)
Elevated manganese
leads to pink water after ozone
Switched from ozone to free chlorine
for primary disinfection for three months
Purchased HACH EZ Series Online Mn Analyzer
2020
plan to install a chlorine dioxide system to oxidize raw water Mn.
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Mn removal requires correct oxidant dosing

Dosing oxidant based on periodic grab samples can miss some raw water changes

Oxidant overdosing or underdosing can be costly with negative impacts to water quality

Oxidant underdosing results in dissolved minerals going out into distribution

Recap

- ATP is a surrogate for microbial content and activity
- Unlike other microbial tests, ATP analysis can be done online with results in about 7 minutes
- Using online ATP to demonstrate LRV can show better results than traditional LRV testing such as TOC and conductivity

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EZ Series: Platform Overview




Voltammetry	Titration	Ion-selective E.	Colorimetry
• Arsenic	• Alkalinity	• Fluoride	• Iron / Manganese
• Mercury	• Hardness	• Chloride	• Low Range Hardness
• Lead	• Ammonium	• Sulfide	• Nitrate / Nitrite
• Cadmium	• Sulfate	• Ammonium	• Orthophosphate

Specialized Methods

- ATP Chemiluminescence
- Total Phosphorus / Nitrogen
- WWTP Influent Toxicity
- Volatile Fatty Acids

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Presenter Biographies

Jana Safarik, MBA
Principal Scientist, Orange County Water District, CA
Research & Development Department
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Jana Safarik is a Principal Scientist in the Research and Development (R&D) Department at the Orange County Water District (OCWD). As a member of the R&D Department, she conducts applied research that supports OCWD's operational goals through experimental design and development of new methods and processes. She has managed and participated in studies that include investigating reverse osmosis membrane fouling mechanisms; mechanisms of microfiltration fouling; water quality; and pilot scale evaluations of pretreatment technologies including microfiltration and reverse osmosis. Currently she is leading a study on novel online surrogates, which includes ATP, to monitor reverse osmosis performance in reuse applications.

David Miller, PE
Deputy Director - Water Supply, City of Manchester Water Works, Manchester, NH
(603) 792-2851
DMiller@manchesternh.gov

Dave Miller is the Deputy Director, Water Supply for the Manchester Water Works. His responsibilities include providing planning, coordination, and engineering design/support for various waterworks projects as well as personnel and facility management, and he is the primary operator of Manchester's 50 million-gallon-per-day conventional water treatment plant. Manchester's drinking water treatment facility is one of only sixteen treatment facilities in the nation recognized by the Partnership for Safe Water for "Excellence in Water Treatment".

Licenses:
Professional Engineer/Civil Engineer (NH, MA, & FL)
NH Water Works Operator, Treatment Grade 4

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Applications Development Manager – Hach
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