How and Why to Monitor ATP for Biological Growth

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Agenda

- Overview of the Hach Company
- Hach and LuminUltra
- What is ATP
- Options for testing
- What is the value of knowing the microbial load
- Advance testing from LuminUltra
- Process ATP testing is EZ

Overview of Hach Company

- **Began in 1947 in Ames, IA**
- **1999: Acquired by Danaher Corporation**
- **Manufacturer of industrial and municipal water analysis solutions**
  - process and laboratory instruments
  - chemistries
  - service and software
- **Innovation leader**
  - 527 patents, 130 patent families
  - strong investment in R&D and acquired technologies

- **OUR MISSION**
  Ensure water quality for people around the world.

- **OUR VISION**
  We make water analysis better—faster, simpler, greener and more informative—via unsurpassed customer partnerships, the most knowledgeable experts, and reliable, easy-to-use products.

HACH®
Be Right™

Overview of Hach Company

- **70+ RSM's**
  - Regional Sales Managers
- **25+ CAM - KAM – ADM – TSS - CSS**
  - CAM - Corporate Account Managers
  - KAM - Key Account Managers
  - ADM - Application Development Managers
  - TSS - Technical Sales Specialist
  - CSS - Complex Sales Specialist
- **100+ Field Service Technicians**
  - Field Service Partnerships
  - Startups, Commissioning and Training
- **41+ Technical Support Representatives**
  - Global Customer Support
- **12+ Bench Service Technicians**
  - Two service centers for repair and certification

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Hach and LuminUltra Teaming Up

May of 2013

- Hach is a non-exclusive distributor of the LuminUltra Product Line
- Tech Support will be prepared to answer questions related to the following
  - Pre-Sale questions related to LuminUltra product offering
  - Ability to identify customers that may be interested in ATP testing
  - Ability to specify the correct LuminUltra test kits for different applications
  - Post-Sale troubleshooting of LuminUltra product offering
  - Exhibit elite level of support, ownership, and product knowledge LuminUltra product line

About LuminUltra

Founded in 1995, LuminUltra is a biological diagnostic testing company headquartered in Canada with operations in 6 countries. It is widely recognized globally as a leader in developing tests and reagents for environmental, industrial, and diagnostic monitoring and is a key supplier of COVID-19 clinical testing reagents to the Government of Canada. Customers in over 80 countries trust LuminUltra's technology, production reliability and history of customer service excellence to deliver their essential services in a safe state.

6
LuminUltra offices spread across the globe

3.5K
Customers from around the world leverage LuminUltra's testing solutions

80+
Countries with customers that rely on LuminUltra's products and services

$345M
In customer value delivered to date

25
Years of exceptional production reliability and innovation

500K
Clinical COVID-19 testing reagents per week being supplied to Canada

Melbourne

LuminUltra proudly serves some of the top companies in the world including:

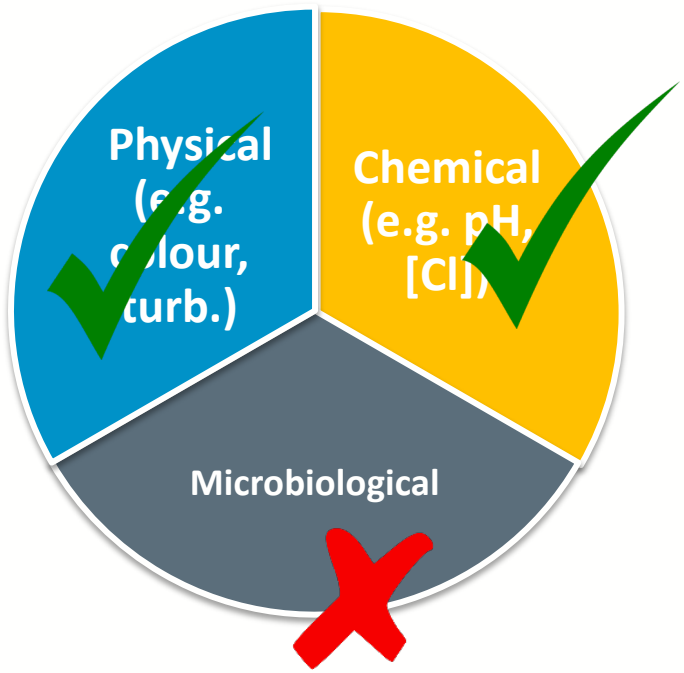
ExxonMobil SUEZ VEOLIA DUPONT ECOLAB Canada

LUMINULTRA®

The Water Quality Toolbox

- Many physical and chemical parameters can be determined in minutes (or instantly via online analyzers).
- The technology has not existed to allow microbiological analyses to be done in the field and produce results quickly.

- This results in significant limitations in water quality control capabilities.



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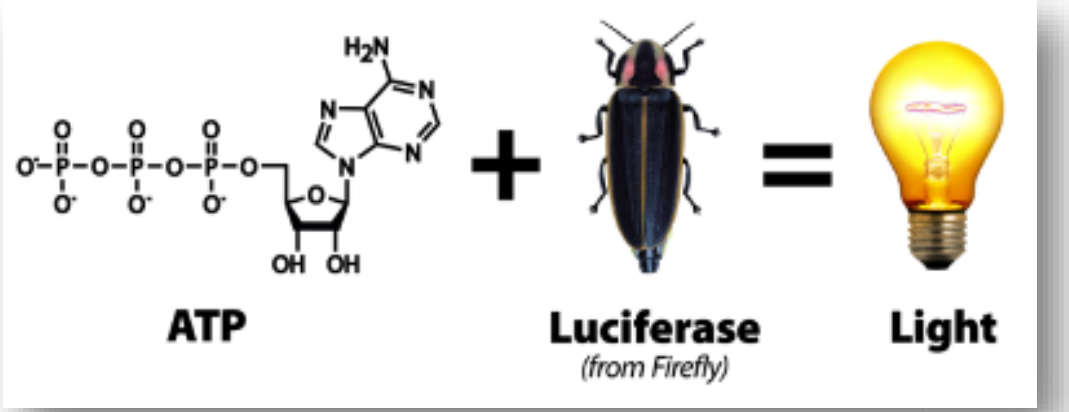
The Problem

- Several Hach products give water testers the ability to *quickly* and easily assess several water quality parameters, such as:
  - Temperature
  - pH
  - Alkalinity
  - Turbidity
  - Color
  - TDS

- But what about *quick assessments* about *biological activity*? Options are very limited.

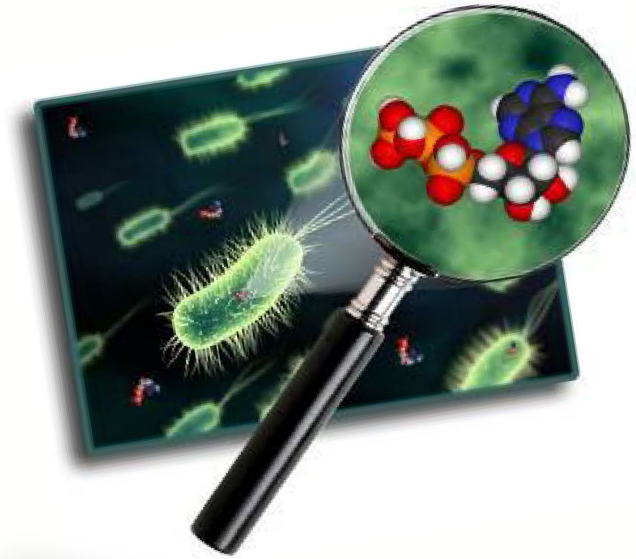
What is ATP?

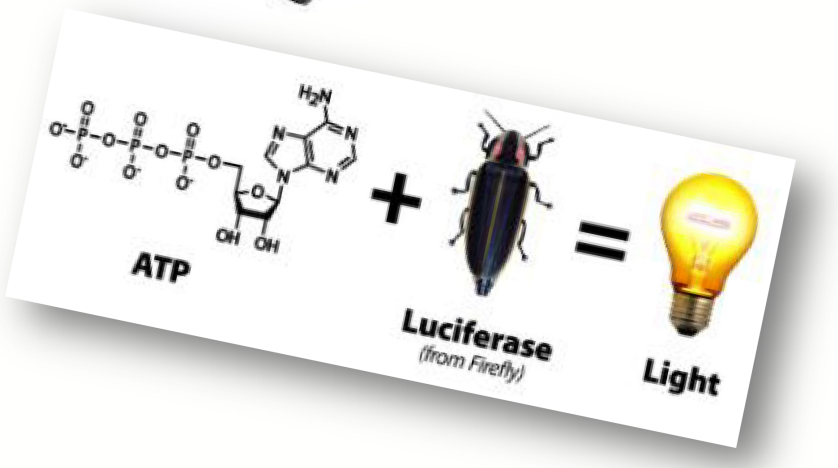
- ATP = Adenosine Triphosphate
  - Primary energy carrier for all life.
  - Measurement takes only minutes.
- Since ATP is present in ALL living cells, quantifying it enables you to detect the entire population rather than just culturable cells.
- ATP testing has been used in food & medical hygiene for decades.



The Basics of ATP Monitoring

- **ATP** = **A**denosine **Tri**phosphate
  - Primary energy carrier for all life.
  - Measurement takes only minutes.
- LuminUltra is the **first** and **only** company to provide 2nd Gen. technology designed for fluid systems (far more sensitive, robust and reliable).

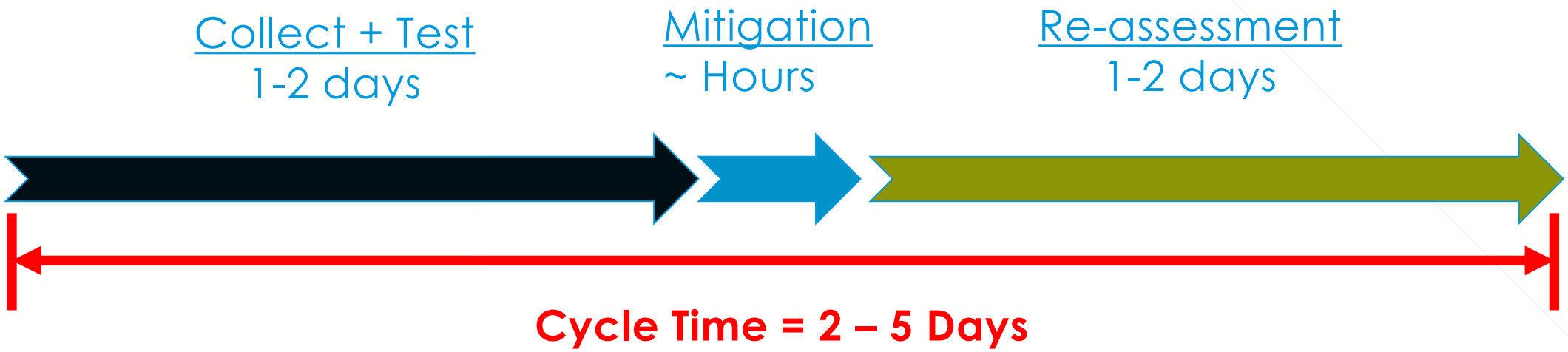




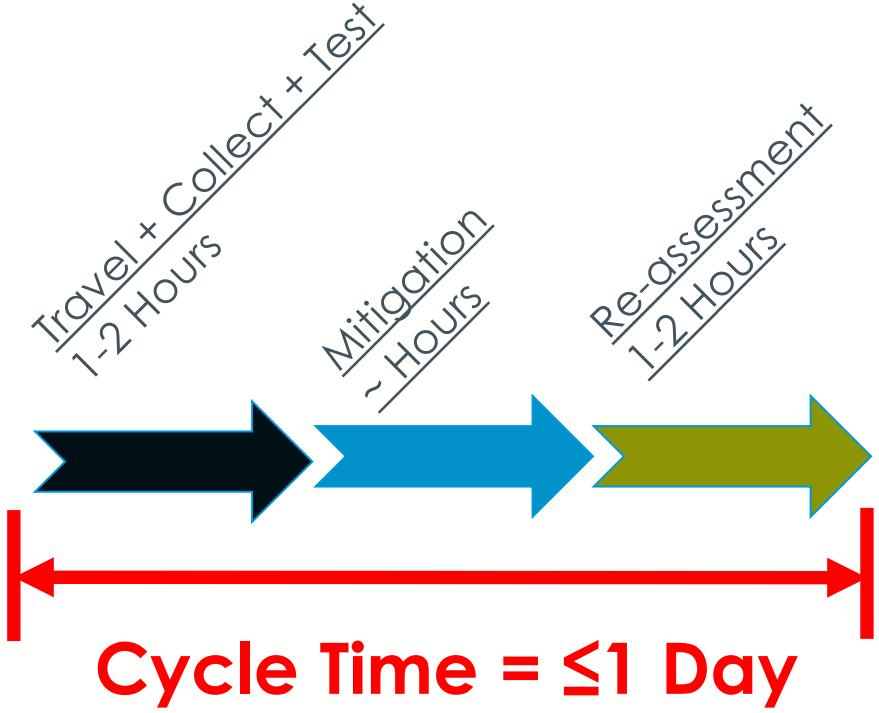
Industry Standard – HPC

- 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!

Strategy: Traditional Culture Tests



Strategy: In-field ATP testing



Point-and-shoot strategy can be applied to isolate the root cause and solve problems on-the-spot.

What are the results of uncontrolled microbial growth?

- Biofilm accumulation
- Elevated disinfectant demand
- Taste & odor, cosmetic issues
- Non-compliance
- Premature infrastructure degradation (i.e. MIC)

Which of these can be managed using compliance tests?

Limitations of Traditional Microbiological Testing

- None of the problems discussed on the previous slides are traced to a single type of organism – they are caused by the community as a whole.
- Attempts at total microbial content (e.g. HPC) are slow and a poor representation of the total population.
- The tools being used are not appropriate for the objective!

"90-99.9% of the bacteria found in water systems are not culturable in common laboratory media."

Risenfeld, 2004

What are the costs of uncontrolled microbial growth?

- Clean ≠ Compliant! Significant costs are incurred as a result of general growth.
- Several hours and large volumes of water required for flushing programs. Adds up to >$122 US/hour to flush.

  Assumptions:

  - Water value = $2 US/1000 USgal

  - Hydrant flow rate = 75 USgpm
- $1/person/day for boil water advisory (conservative estimate).

Costs of Line Breaks

Location	Miles of Pipe	Total # of Breaks	Cost to Manage Annual Breaks[1]
Phoenix	5,400	1350	$4,050,000
Dallas	4,600	1150	$3,450,000
Kansas City	1,912	478	$1,434,000
Macon	1,400	350	$1,050,000

- **Average line break frequency:**

  23-27 breaks/100 miles of pipe/year (Kirmeyer et al)

- **Direct costs to repair a break: $3000**

  (American Water Works Service Company)

Costs of Line Breaks

Location	Miles of Pipe	Total # of Breaks	Cost to Manage Annual Breaks[1]	Potential Savings
Phoenix	5,400	1350	$4,050,000	$405,000
Dallas	4,600	1150	$3,450,000	$345,000
Kansas City	1,912	478	$1,434,000	$143,400
Macon	1,400	350	$1,050,000	$105,000

- Assume 50% of breaks due to corrosion (the balance is due to construction incidents, etc.)
- Also (conservatively) assume that enhanced control reduces field service time by 10%.

As a result…

- People have learned to live without microbiological data.
  - "We don't do micro. That's for the people across town/state lab/etc."
  - "We just keep our chlorine high."
  - "We just look at Total Coliform/E.Coli. We don't really care about other stuff."
- Many are aware of limitations but aren't aware that a solution exists.

As a result…

- If a problem is detected using traditional microbiological tools, it has been there for at least a couple of days.
- Since the time of sample collection, the problem may (and likely is) worse and spread downstream.
- What would it be worth to you to know about the problem immediately?

The Solution

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

PRODUCT OVERVIEW

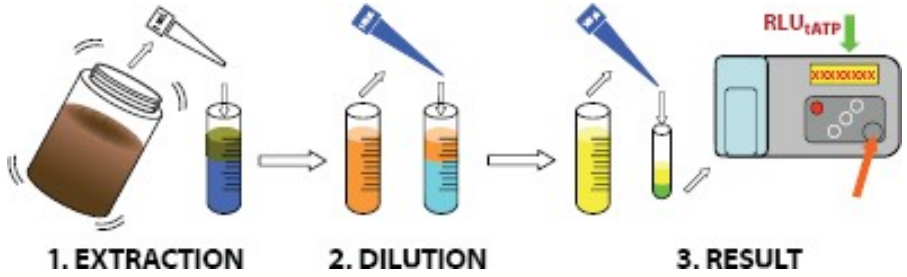
2nd Generation ATP

“The first line of defence”

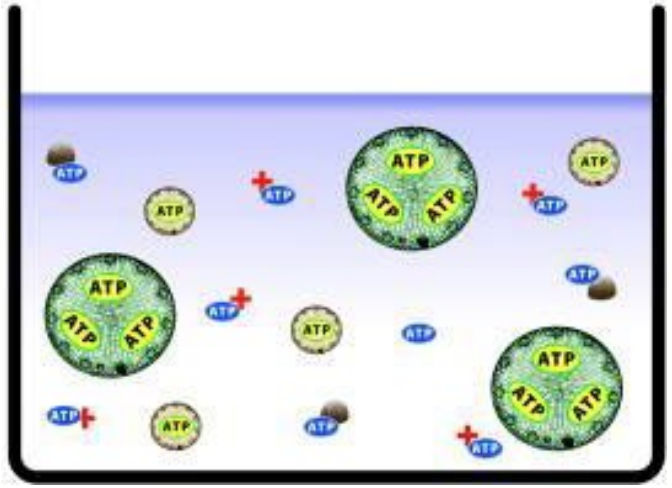
- Trusted solution for water-related industries for 15+ years;
- Rapid measure of total bioburden in < 5 minutes using a simple and portable test protocol;
- Facilitates timely risk assessments to identify areas of concern;
- Drives immediate action (i.e. more specific assays and/or adjustments to treatment strategies).

The Key: Cellular ATP (cATP (Cellular ATP))

Non-Filterable Samples: *cATP (Cellular ATP) = tATP (Total ATP) - dATP (Dissolved ATP)*

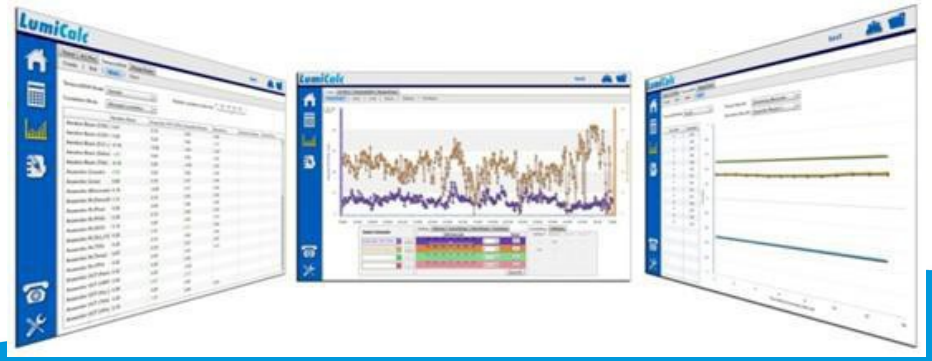


Filterable Samples: *cATP (Cellular ATP) Direct*



Product Offering

- Luminometer-PhotonMaster
  - Powered via USB to laptop or desktop computer
- Application Specific Test Kits
  - Quench-Gone Aqueous (QGA)
  - Quench-Gone Organic Modified (QGO-M)
  - QuenchGone21 Wastewater (QG21W)
  - QuenchGone21 Industrial (QG21I)
  - QuenchGone21 Specialty (QG21S)
  - DSA Test Kit
- LumiCalc Software
  - Significant time savings in the organization, analysis, and reporting of data – spend minutes to achieve what took hours with traditional method.
  - Get interpretation as results are collected to make faster and better decision.
  - Direct connection to PhotonMaster saves time tabulating results and protects your data



Hach plus LuminUltra

QuenchGone AQUEOUS

QuenchGone21 WASTEWATER

QuenchGone21 INDUSTRIAL

QuenchGone21 SPECIALTY

Deposit&Surface ANALYSIS

QuenchGone ORGANIC-M

HACH®

Be Right™

HACH®

Be Right™

6 Test Kits + 1 Equipment Set

LUMINULTRA® SEE THE LIGHT

QuenchGone AQUEOUS

- ✓ Purified
- ✓ Drinking
- ✓ Cooling

QuenchGone ORGANIC-M

- ✓ Fuels
- ✓ Metalworking
- ✓ Oilfield

- ✓ Papermaking
- ✓ Pulping
- ✓ Wash Waters

- ✓ Polymers
- ✓ Slurries
- ✓ Adhesives

QuenchGone21 SPECIALTY

- ✓ Deposits
- ✓ Biofilm
- ✓ Slimes
- ✓ Surfaces

- ✓ Wastewater
- ✓ Bioreactors
- ✓ Effluent
- ✓ Bioprocessing

Be Right™

QGA Test Kit

QGA Test Kit Contents & Storage Conditions

Component (LuminUltra P/N)	Storage	Shelf Life
Luminase™ Enzyme & Buffer Vials (**Lu-3mL-FD**) *Luciferase Enzyme Reagent, 3mL*	4 to 25ºC	6 to 12 mo*
UltraCheck ™ 1 Dropper Bottle (**UC1-5mL**) *1 ng ATP/mL Standard, 5mL*	4 to 25ºC	18 mo
UltraLyse ™ 7 Bottle (**UL7-125mL**) *ATP Extraction Reagent, 125mL*	4 to 25ºC	18 mo
UltraLute™ (Dilution) Tube, 9mL (**ULu-9mL-50R**) *ATP Dilution Reagent, 9mL*	4 to 25ºC	18 mo
Quench-Gone Syringe Filters, 25/pk (**DIS-SFQG-25**)	-	-
60mL Syringe, PP/Neoprene, 25/pk (**DIS-S60-25**)	-	-
100 to 1000µL Blue Pipet Tips, 100/rack (**DIS-PT1-100R**)	-	-
10 to 200µL Yellow Pipet Tips, 96/rack (**DIS-PT01-96R**)	-	-
12x55mm Test Tubes, 50/pk (**DIS-CT12-50**)	-	-

QGA – Quench-Gone Aqueous. Use for water samples whether fresh or brackish from any source when microbial control is required.

QGA Quick-Reference Guide

Step 2 - Cellular ATP (cATP™) Analysis

2.1 – MEASURE SAMPLE VOLUME

Determine volume and filter sample.

Sample Type	Volume (mL)
Cooling or Process Water	10 to 25
Fresh Brackish & Salt Water	25 to 50
Reclaimed Water, Effluents	25 to 50
Drinking and Sanitary Water	50 to 100
High Purity Water	> 100

2.2 – FILTRATION

Filter sample.

2.3 – EXTRACTION

Extract ATP from filter & dilute.

2.4 – ASSAY

Measure ATP concentration.

NOTE: If $RLU_{cATP} \leq 10$ using a PhotonMaster or Lumitester C-110, you are below the low- detection limit

NOTE: If $RLU_{cATP} \leq 50$ using a PhotonMaster or Lumitester C-110, consider accounting for background (RLU_{bg}). See Test Kit Instructions for guidance.

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QG21W Test Kit

QG21W Test Kit Contents & Storage Conditions

Component (Part Number)	Store At	Shelf Life
Luminase™ W Enzyme & Buffer Vials **(LuW-3mL-FD)** *Luciferase Enzyme Reagent, 3mL*	4 to 25ºC	6 to 12 mo*
UltraCheck™ 1 Dropper Bottle **(UC1-5mL)** *1 ng ATP/mL Standard, 5mL*	4 to 25ºC	18 mo
UltraLyse™ 30^{21} (Extraction) Tube, 2mL **(UL30(21)-2mL-50R)** *tATP Extraction Reagent, 2mL*	4 to 25ºC	18 mo
UltraLute™/Resin (Dilution) Tube, 8mL **(ULuR-8mL-50R)** *tATP Dilution Reagent, 8mL*	4 to 25ºC	18 mo
LumiSolve™ (Stabilizer) Tube, 10mL **(LS-10mL-50R)** *dATP Stabilizing Reagent, 10mL*	4 to 25ºC	18 mo
UltraLyse™ 30^{21} (Extraction) Tube, 10mL **(UL30(21)-10mL-25R)** ** *tATP Extraction Reagent, 10mL*	4 to 25ºC	18 mo
100 to 1000µL Blue Pipet Tips, 100/rack **(DIS-PT1-100R)**	-	-
100 to 1000µL Wide-Mouth Pipet Tips, 100/rack **(DIS-PT1WM-100R)**	-	-
10 to 200µL Yellow Pipet Tips, 96/rack **(DIS-PT01-96R)**	-	-
12x55mm Assay Tubes, 50/pk **(DIS-CT12-50)**	-	-
2" x 2" 250µm Mesh Squares, 25/pk ** **(DIS-MESH-25)**	-	-
1.5" x 1.5" Weigh Boat, 25/pk ** **(DIS-WD-25)**	-	-
Scissor-Type Forceps, 1/pk** **(EQP-FOR)**	-	-

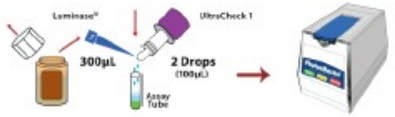
QG21W – QuenchGone21 Wastewater. Designed for quantification of biomass in wastewater treatment bioreactors, influents, and effluents. Also used for fermentation.

NOTE: Kit uses **LuminaseW** Luminase

QG21W Quick-Reference Guide

Step 1 - UltraCheck™ 1 Calibration

Perform one UltraCheck 1 calibration per day or per each set of samples analyzed.



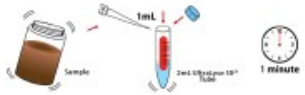
NOTE: If $RLU_{ATP1} \leq 500$ using a PhotonMaster or Lumitester C-110, rehydrate a new bottle of Luminase® for maximum sensitivity.

Step 2 – Total ATP (tATP™)

Included in QG21W™ and QG21Wa™ test kits.

2.1 - EXTRACTION

Add sample to extract ATP.



2.2 – DILUTION

Dilute out interferences.

2.3 – ASSAY

Measure ATP concentration.

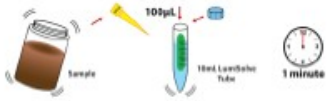
NOTE: If $RLU_{tATP} \leq 10$ using a PhotonMaster or Lumitester C-110, you are below the low- detection limit.

Step 3 – Dissolved ATP (dATP™)

Included in QG21W™ and QG21Wa™ test kits.

3.1 – DILUTION

Add sample to recover ATP.



3.2 – ASSAY

Measure ATP concentration.

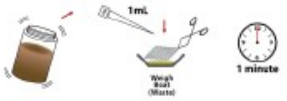
NOTE: If $RLU_{dATP} \leq 10$ using a PhotonMaster or Lumitester C-110, you are below the low- detection limit.

STEP 4a – Floc Bulking ATP (fbATP™)

Included in QG21Wa™ test kit only.

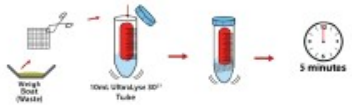
4a.1 - FILTRATION

Filter sample to separate bulking floc.



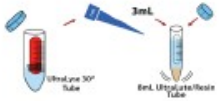
4a.2 - EXTRACTION

Extract ATP from mesh.



4a.3 - DILUTION

Dilute out interferences.



4a.4 - ASSAY

Measure ATP concentrations.

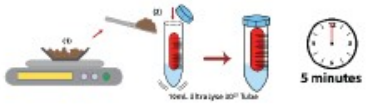
NOTE: If $RLU_{fbATP} \leq 10$ using a PhotonMaster or Lumitester C-110, you are below the low-detection limit.

STEP 4b – Attached Growth ATP (agATP™)

Included in QG21Wa™ test kit only.

4a.1 - EXTRACTION

Extract ATP from sample.



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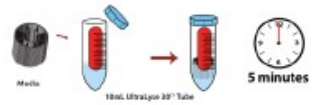
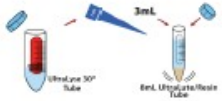


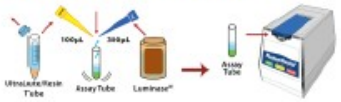
4b.2 - DILUTION

Dilute out interferences.



4b.3 - ASSAY

Measure ATP concentrations.



NOTE: If $RLU_{agATP} \leq 10$ using a PhotonMaster or Lumitester C-110, you are below the low-detection limit.

Municipal Water Management:

Actions driven by ATP test results

- Field-deployable test format enables user to trace up the line to find the source of issues;
- Optimize flushing time/water usage;
- Boost disinfectant/burnout;
- Conduct system audits to optimize secondary microbiological monitoring tools to speciate.

Focus: Storage Tank Surveillance

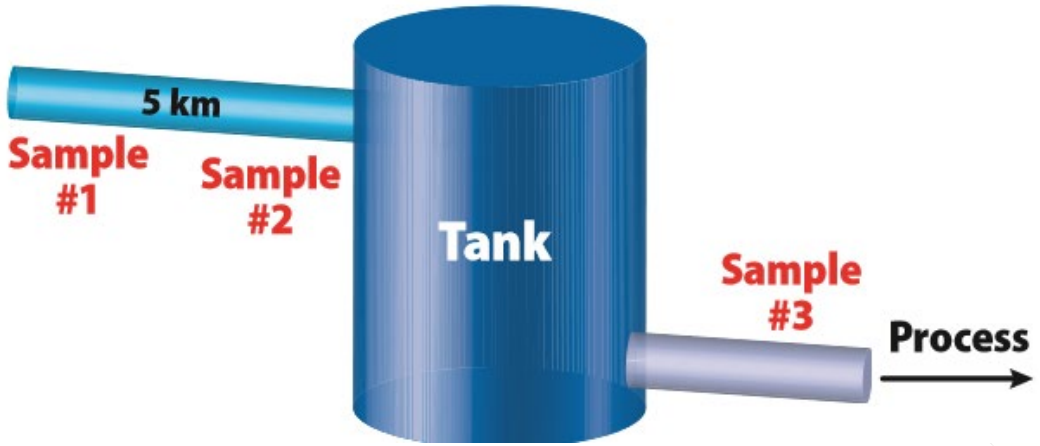
- Storage tanks are often the first point at which regrowth becomes a problem.
- Whether it be due to long water age, stagnation, or infiltration, stored water represents a threat to downstream water quality.

  [ATP]outlet > [ATP]inlet?

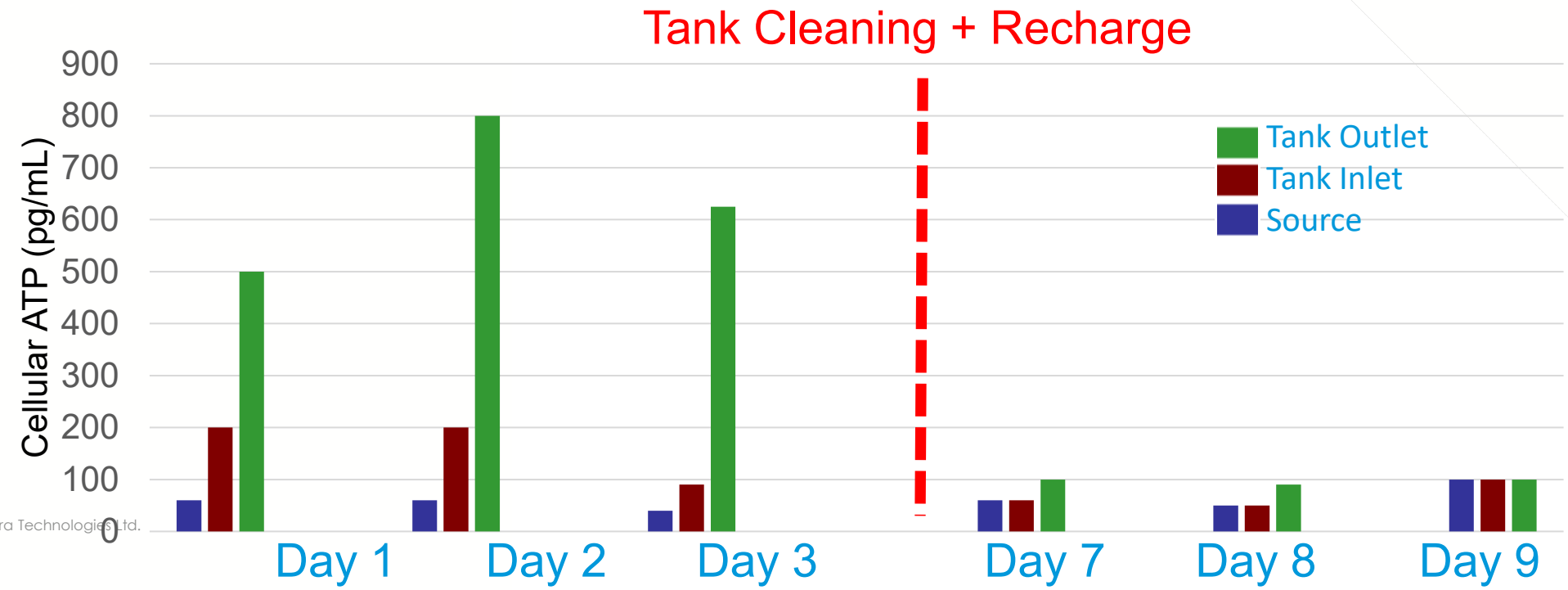
- If ATP leaving the tank is greater than that entering the tank then growth is occurring in the tank.

Focus: Storage Tank Surveillance

- Water quality issues had been apparent through a water delivery line with the source suspected to be a storage tank on-site.
- Samples were drawn at the source, the tank inlet, and the tank outlet.
- ATP tests were done at each location over a 3-day period.



Focus: Storage Tank Surveillance



Focus: Distribution System

1. Diagnose water quality issues as biological or not in minutes;
2. Trace the line to the source;
3. Apply corrective action;
4. Validate actions on-the-spot.

Case Study: Distribution Troubleshooting

- A utility performed a distribution system audit to compare microbiological contamination levels with total chlorine residual.
- To recap: ATP targets for drinking water systems are as follows:

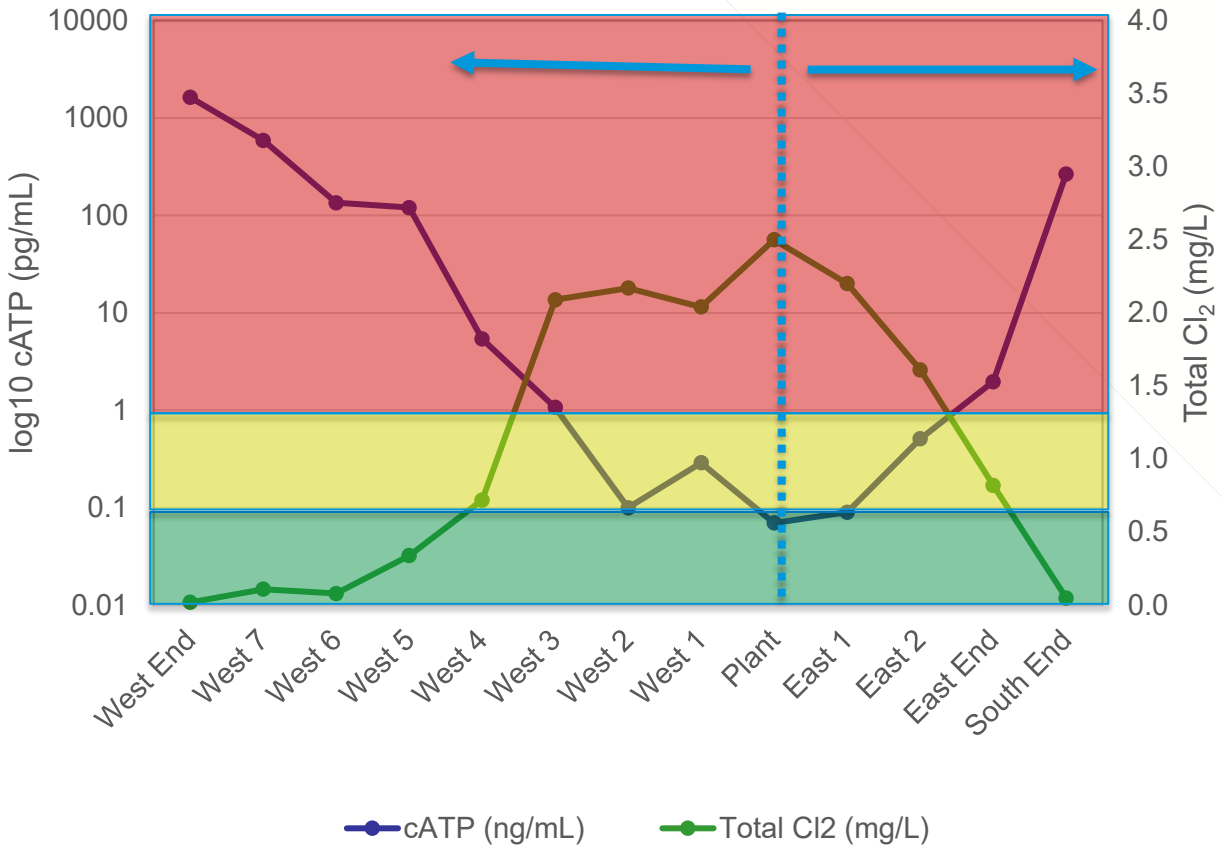
High Risk: >10pg/mL

Moderate: 1 < ATP < 10

Low Risk: < 1pg/mL

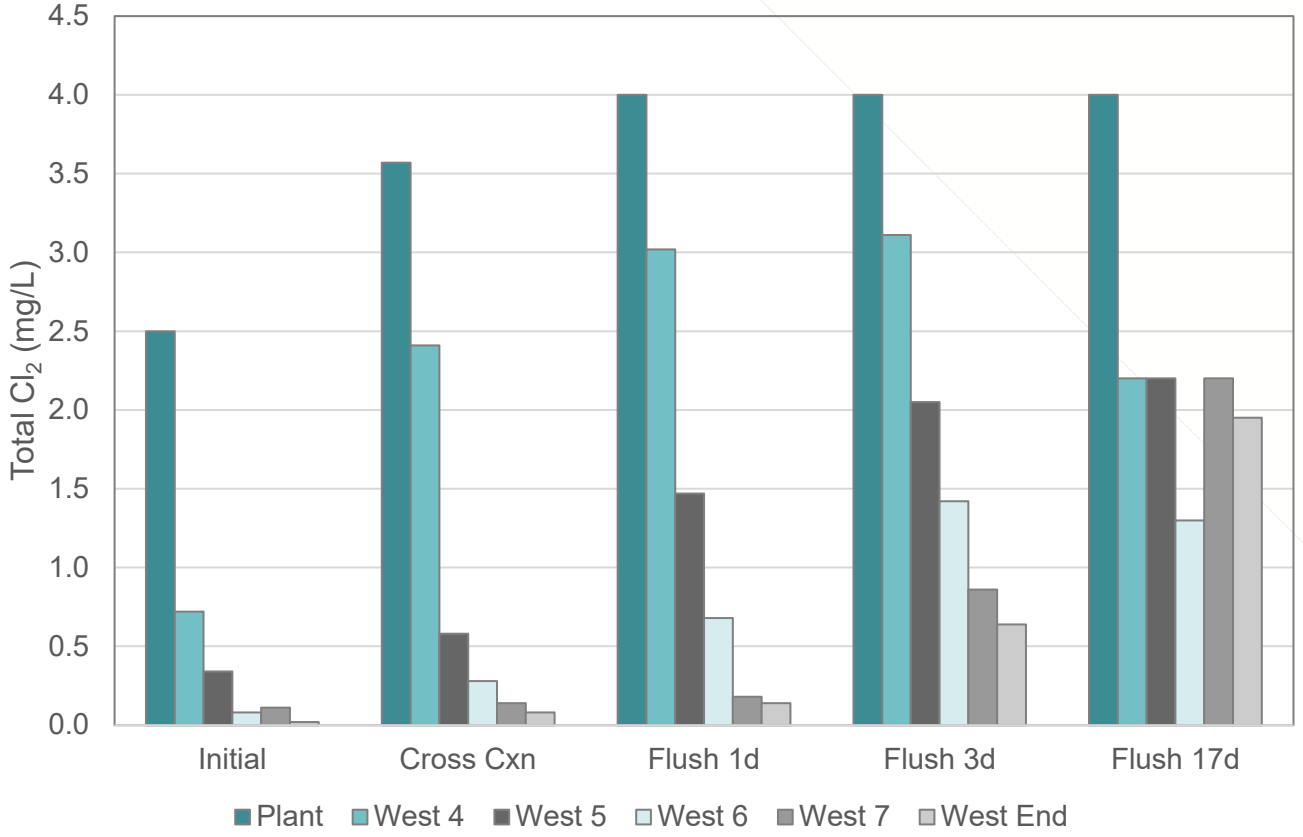
Case Study: Distribution Troubleshooting

- As expected, ATP increased and total chlorine levels decreased with distance from the plant.
- BUT, in some cases ATP results persisted at elevated levels even in areas of adequately high chlorine.



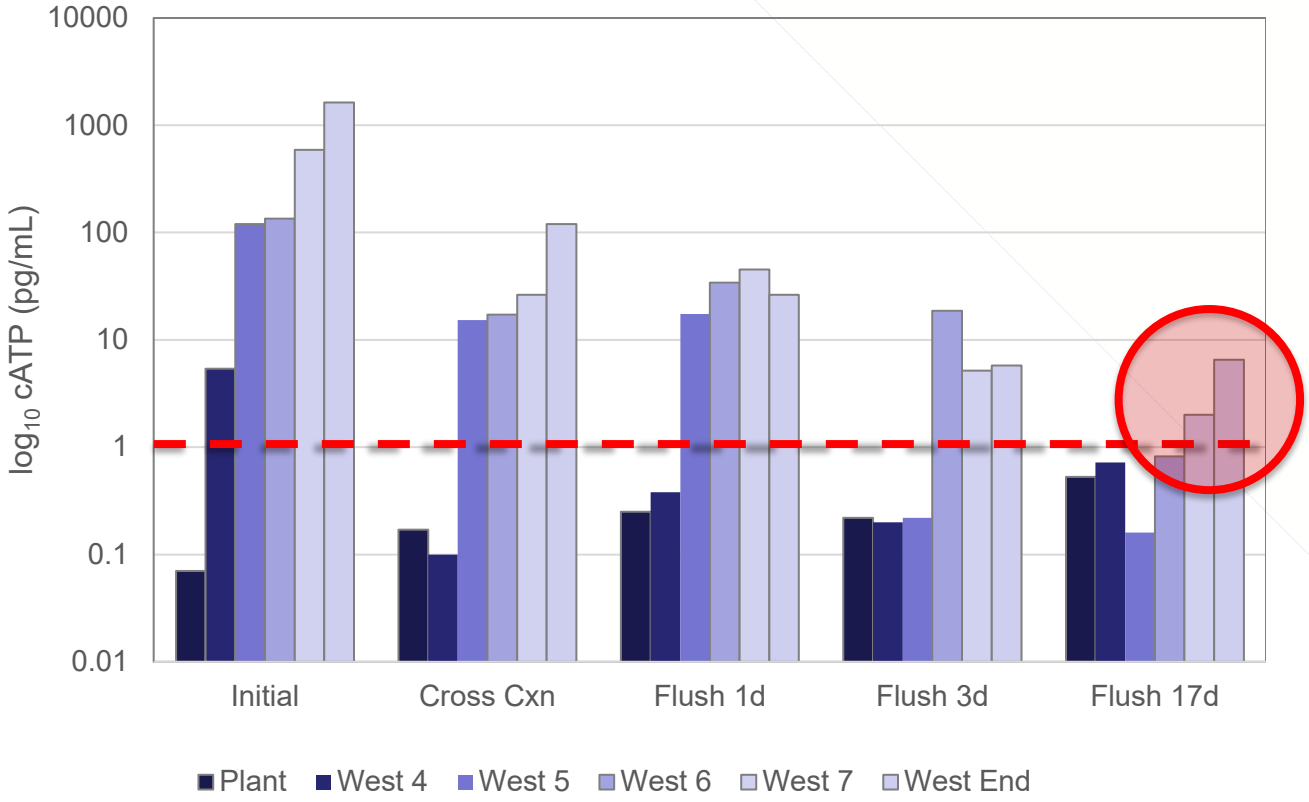
Case Study: Distribution Troubleshooting

- Chlorine was boosted in addition to a flushing cycle.
- Chlorine residuals increased as expected with the highest levels being nearest to the plant.
- After the flush, same levels of residual Cl were observed at all points.



Case Study: Distribution Troubleshooting

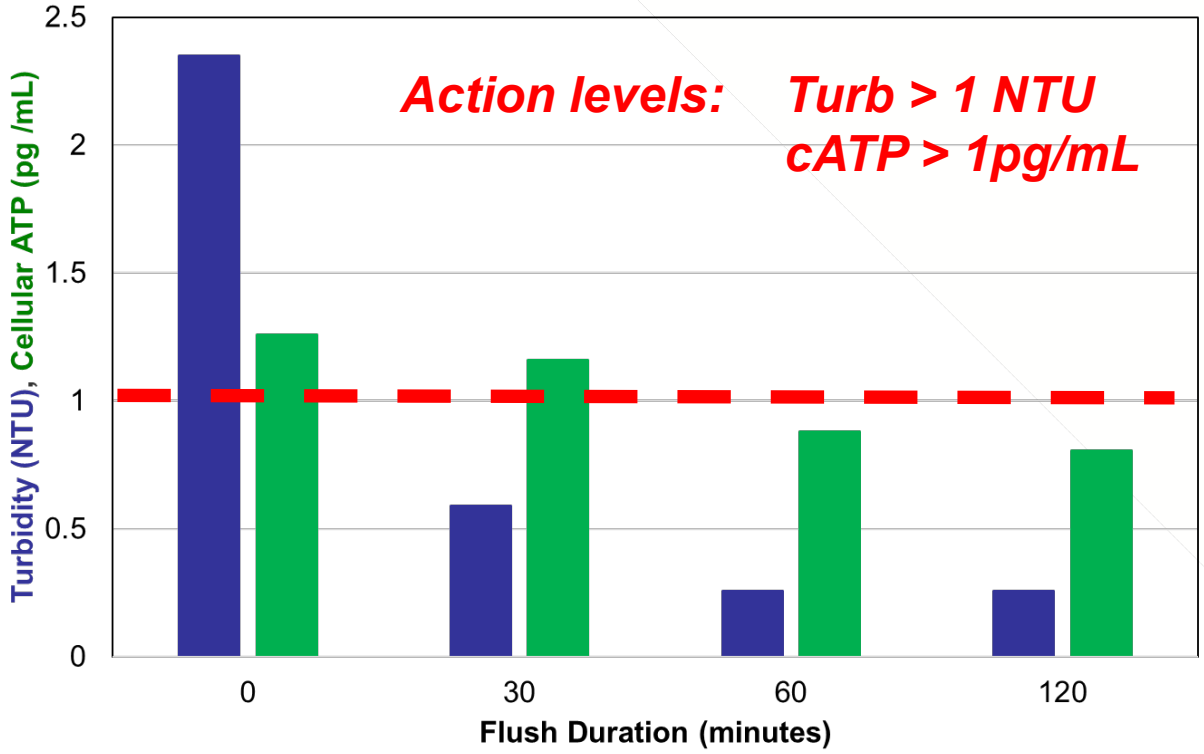
- Despite the re-establishment of adequately high Chlorine, high ATP was still measured at the far ends of the distribution system.
- Localized focus could be placed in this area, whether it be in the form of additional flushing or additional root cause analysis.



Case Study: Flushing

ATP levels dropped significantly after only 30 minutes to below the target 1 pg ATP/ml.

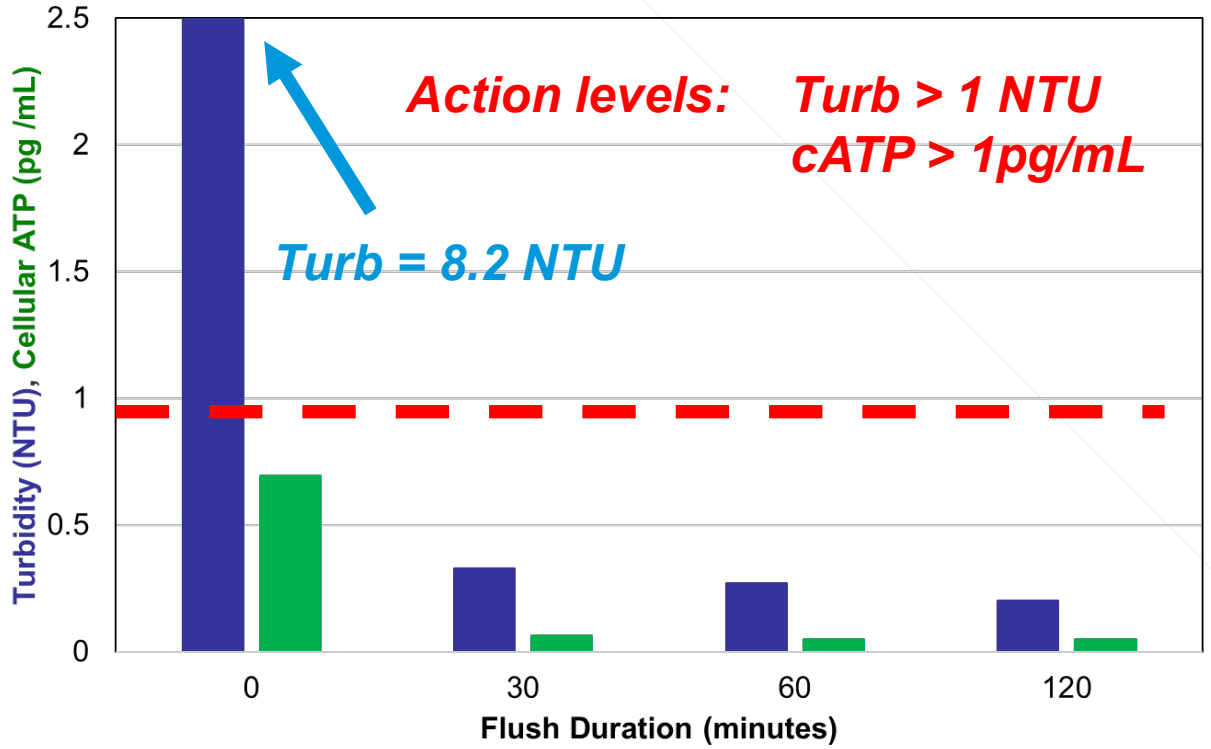
Savings: 2 man hours + 45,000 USgal of water.



Case Study: Flushing

In this case ATP confirmed that the high turbidity was a non-biological issue and flagged the end of the flushing cycle after 30 minutes.

Savings: 3 man hours + 67,500 USgal of water.



Focus: Nitrification

- Controlling nitrification requires a delicate balancing act:
  - NH_3/Cl/pH – all a function of what's in the water, difficult to make sure it's all as it should be.
  - Nitrifying bacteria cannot be detected using HPCs.
  - HPCs detect Denitrifying bacteria, but by that time, it's already too late.

Summary on ATP Testing

- ATP technology overcomes the limitations of traditional microbiology by taking microbiological testing into the field and producing results as quickly as other water quality parameters;
- Reveal, isolate and solve water quality problems in a fraction of the time that would otherwise be needed;
- Use results of in-field ATP tests to drive and prioritize additional testing to further characterize water quality.

PRODUCT OVERVIEW

GeneCount™ qPCR

Isolates specific microbes

- qPCR testing has historically been complex, expensive, and a significant investment that only research labs would pursue.
- GeneCount is very "on brand" with LuminUltra's traditional approach: practical and portable yet refusing to sacrifice accuracy for the sake of simplicity.
- Value Proposition: Test for the specific threats that concern you most without involving a lab, thereby saving significant time and money.
- Expandable platform to include numerous other tests in the future, including infectious diseases in addition to more pathogens and troublesome microbes.

PRODUCT OVERVIEW

GeneCount™ qPCR

Additional Assays:

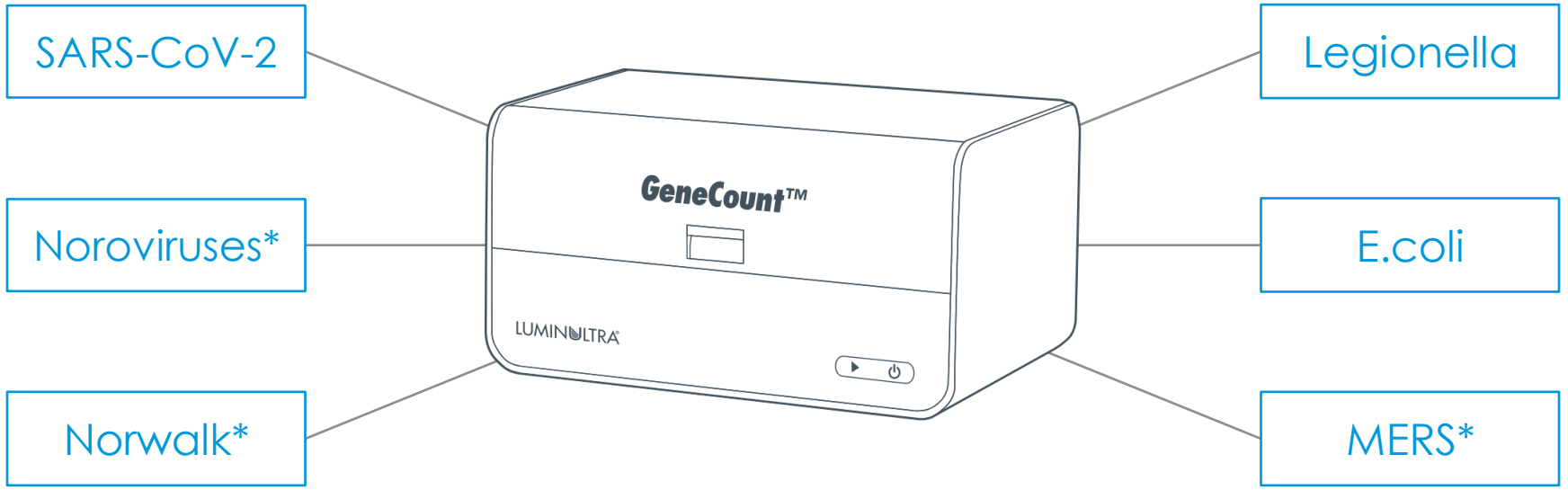
- Total Prokaryote
- Sulfate-Reducing Prokaryote
- Sulfur-Oxidizing Prokaryote
- Methanogens
- Iron Reducing Bacteria
- Total Fungi
- Total E.Coli
- Legionella sp.
- **NEW:** SARS-CoV-2

Coming Soon:

- Legionella pneumophila
- Nitrifying Prokaryotes
- Nitrate-Reducing Bacteria
- Acid-Producing Bacteria
- Pseudomonas

Be Right™

Having a microbial safety plan is crucial to ongoing risk management



LuminUltra's multifunctional GeneCount line provides both the platform and assays needed for ongoing pathogen defense!

The EZ Series: online water analysis made easy

ORGANIC LOAD ANALYZERS

Total Organic Carbon
Chemical Oxygen Demand

NUTRIENT ANALYZERS

Nitrate, phosphate, ammonia
Total N, Total P

TRACE METAL ANALYZERS

12 heavy / trace metals
Ag, As, Cr, Hg, Pb, Se

NICHE WASTEWATER ANALYZERS

Volatile fatty acids, FOS/TAC
Influent Toxicity

Matrix: WATER

EZ SERIES:

Hach's advanced analyzer platform for online water analysis.

MICROBIOLOGY ANALYZERS

Adenosine Triphosphate
(ATP)

GENERAL WATER ANALYZERS

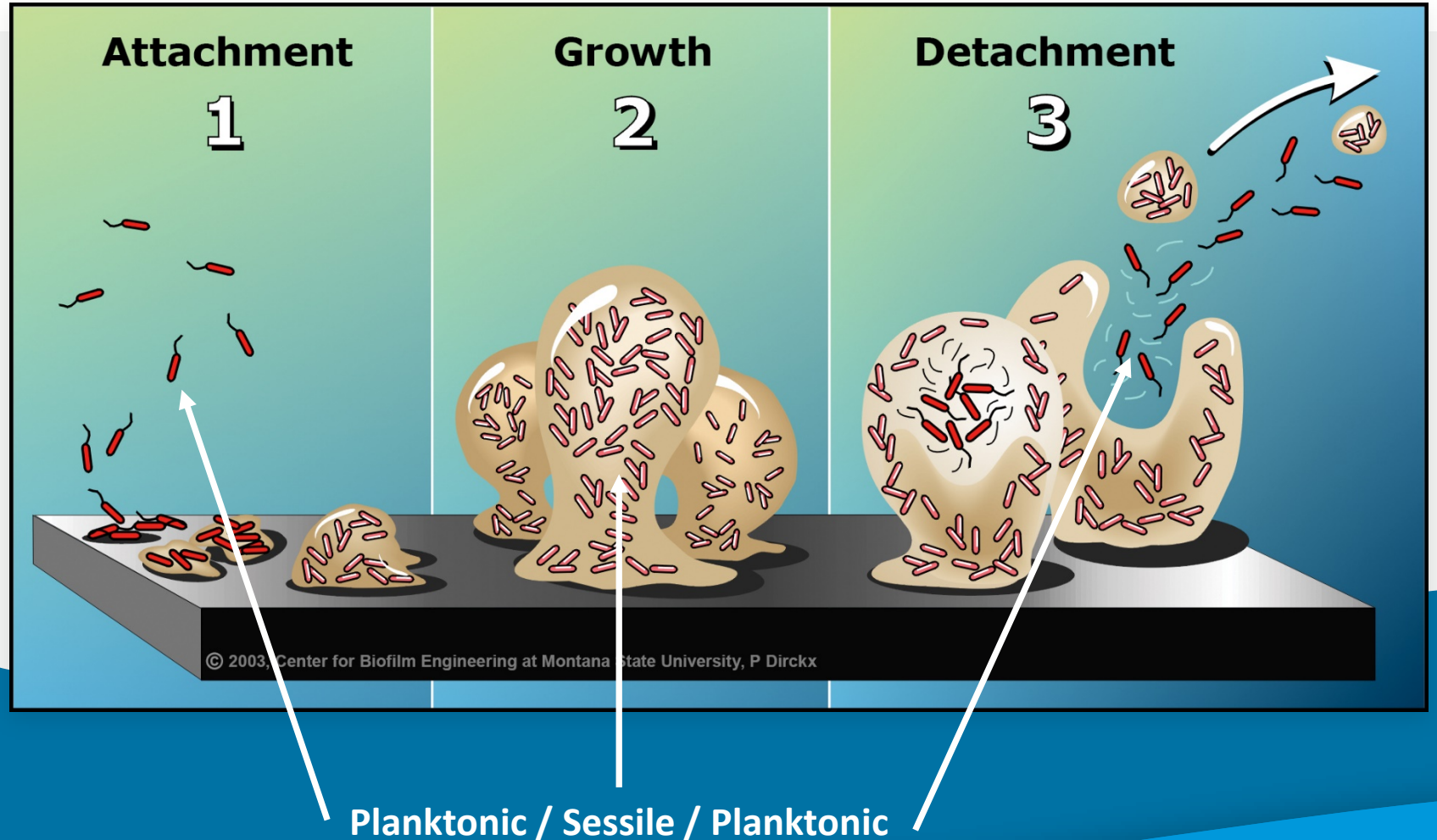
Chemical parameters
From A tot Z

ANALYZER PORTFOLIO

HACH®
Be Right™

A Dynamic Process – Real Time Monitoring Needed

* Graph by Montana State University



The Objectives:

- "Healthy biofilms will release lumps of bacteria once fully grown: sessile bacteria turn planktonic again: this is a risk.
- When Biocides are dosed they will only touch the surface of the biofilm releasing similar lumps of bacteria: risk.
- A clean system can be obtained by: cleaning and monitoring of low concentrations planktonic bacteria.

HACH
Be Right™

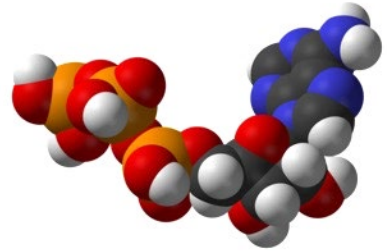
Cell dies and ATP is rapidly degraded

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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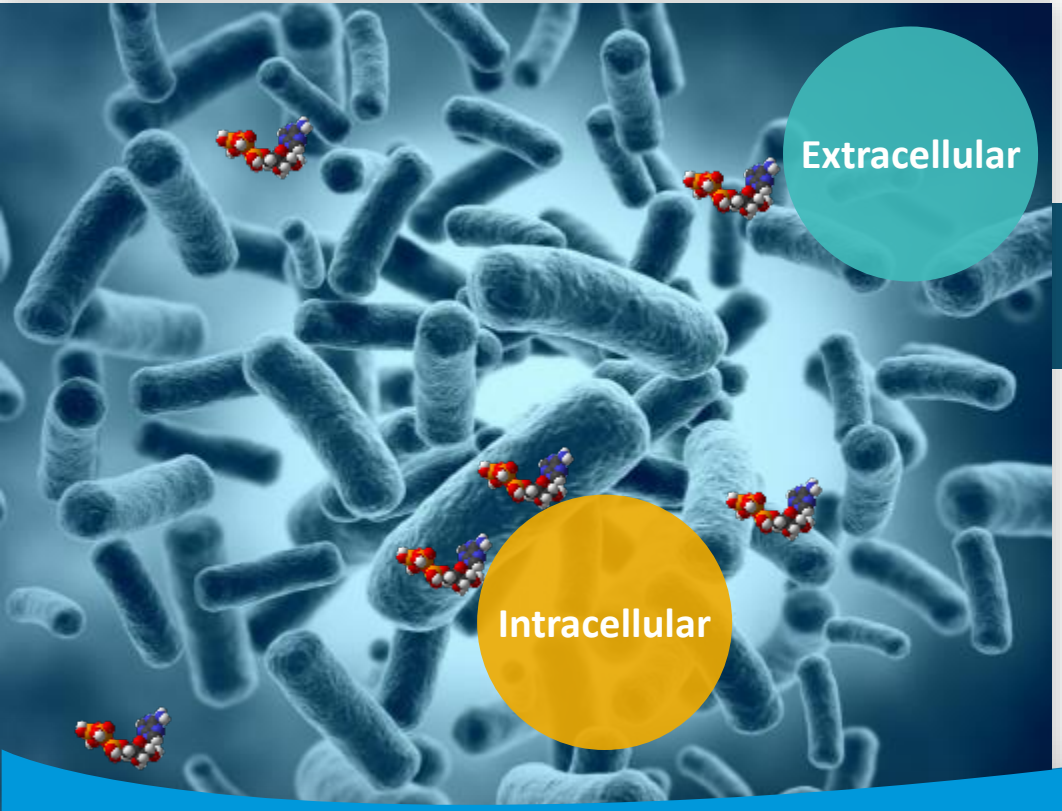
Proprietary Sample Pretreatment to Detect Living Organisms



What is the relevance of measuring the different ATP portions?

- Extracellular ATP or free ATP is the portion of ATP released by dead cells
- Total ATP is obtained after lysis of the biomass by sonication of the sample
- Intracellular ATP is the portion of ATP from the metabolically active (living) organisms

Intracellular ATP = Total ATP – Extracellular ATP

Bonus Material: Free ATP can be used in reverse osmosis (RO) applications to monitor contaminant removal

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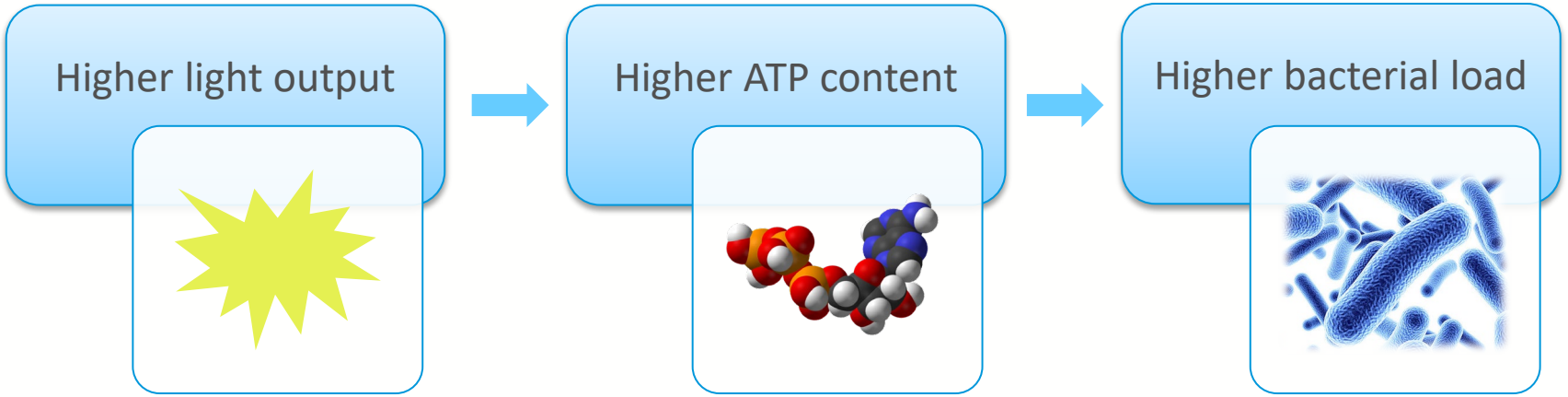
ATP chemiluminescence reaction

ATP assays using luciferin/luciferase reactions allow to assess microbial load 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.



EZ7300 Series - General

What?

The first microbiology analyzer using the ATP firefly assay and complying with international standard method **ASTM D4012-81**

The on-line microbiology analyzer brings operators

- Fast results (few minutes ≈ real-time data)
- Automation
- Analytical performance
- Reliability

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Hach EZ7300 Series ATP Analyzer

The first microbiology analyzer using the ATP firefly assay and complying with international standard method **ASTM D4012-81**.

- Fast results (few minutes ≈ real-time data)
  - 10 minutes can be delayed to 2.5 hours
- Analytical performance, LOD of 0.05 pg/mL
- Up to 8 sample streams possible
- Highly sensitive and stable ATP reagents
- Automation and cleaning
  - Rinsing after each sample.
  - Cleaning with HCl to break down any biofilm.
  - Cleaning with NaOH to hydrolyze remaining bacteria

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EZ7300 Series - High analytical performance

- Complete ATP recovery: detection of intracellular, extracellular and total ATP
- Rapid measurement: 7 - 10 minutes (including lysis)
- No delay between sample take-off and measurement
- Smart features: automatic calibration and 3-step cleaning protocol
- Low limit of detection (LOD): 0.05 pg/mL (0.1 pM) ATP *
- Extended reagent stability (see further)
- Factory configured, tested and calibrated

* 0.05 pg ~ 50 *E. coli* sized bacteria

EZ7300 Series – Proprietary sample pretreatment

Question: what is one of the main challenges in measuring the microbial load (contamination) in water?

Answer: in order to have a clear picture of the microbial load it is important to differentiate ATP portions within living cells from non-living cells

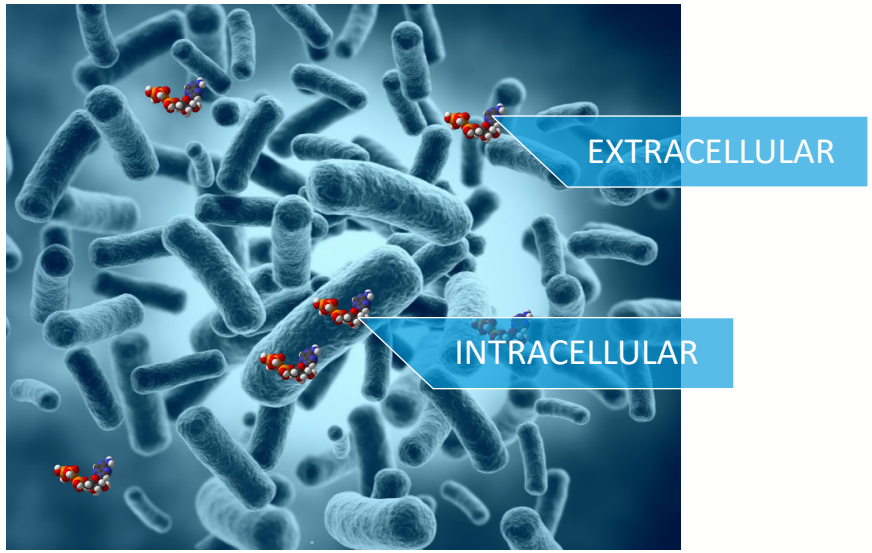
ATP in the water source can be located…

Either inside bacteria or other cells

= intracellular

Or freely in the water surrounding the cells

= extracellular or free ATP



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EZ7300 Series – Proprietary sample pretreatment

What is the relevance of measuring the different ATP portions?

- Extracellular ATP or free ATP is the portion of ATP released by dead cells
- Total ATP is obtained after lysis of the biomass by sonication of the sample
- Intracellular AP is the portion of ATP from the metabolically active (living) organisms

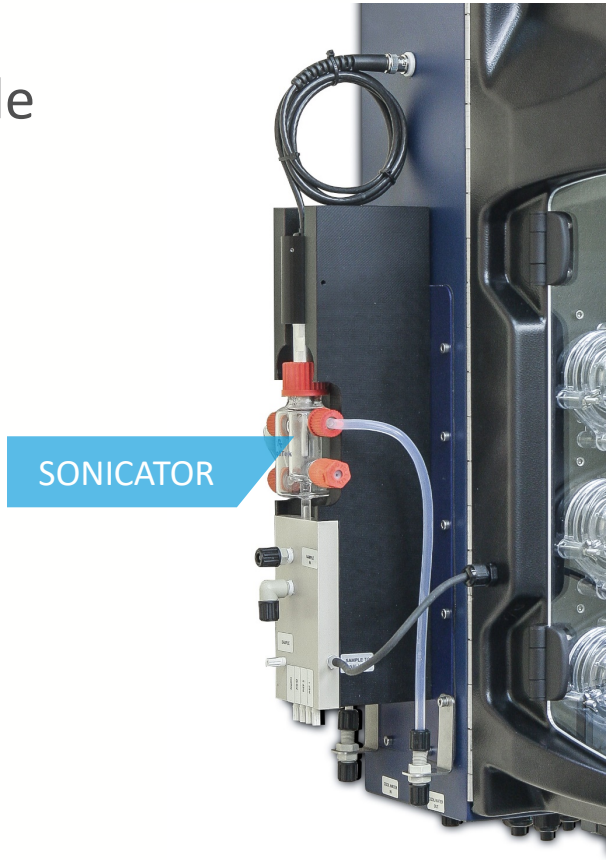
Or:

Intracellular ATP = Total ATP – Extracellular ATP

EZ7300 Series – Proprietary sample pretreatment

Solution: EZ Series proprietary sample pretreatment unit performs a controlled ultrasonic lysis of the sample which disrupts the living cells

- Sampling
- Addition luciferase and luciferin
- 1st light output correlates with **free ATP**
- Cell lysis with ultrasonic treatment
- Addition luciferase and luciferin
- 2nd light output correlates with **total ATP**



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Real time monitoring of raw water intake and treated water

The objectives:

At the Alfred Merritt Smith Water Treatment Facility

- Obtain real-time information to further optimize the ozonation of the raw water coming from Lake Mead.
- Refine and optimize the Chlorine gas disinfection process used on the finished drinking water.

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Saint Paul Regional Water Services' McCarron's Water Treatment Plant

Water Use (In Million Gallons)
Average daily - (2016) 38.2

Area Supplied (In Square Miles)
Saint Paul - 56.2
Suburbs - 66.6

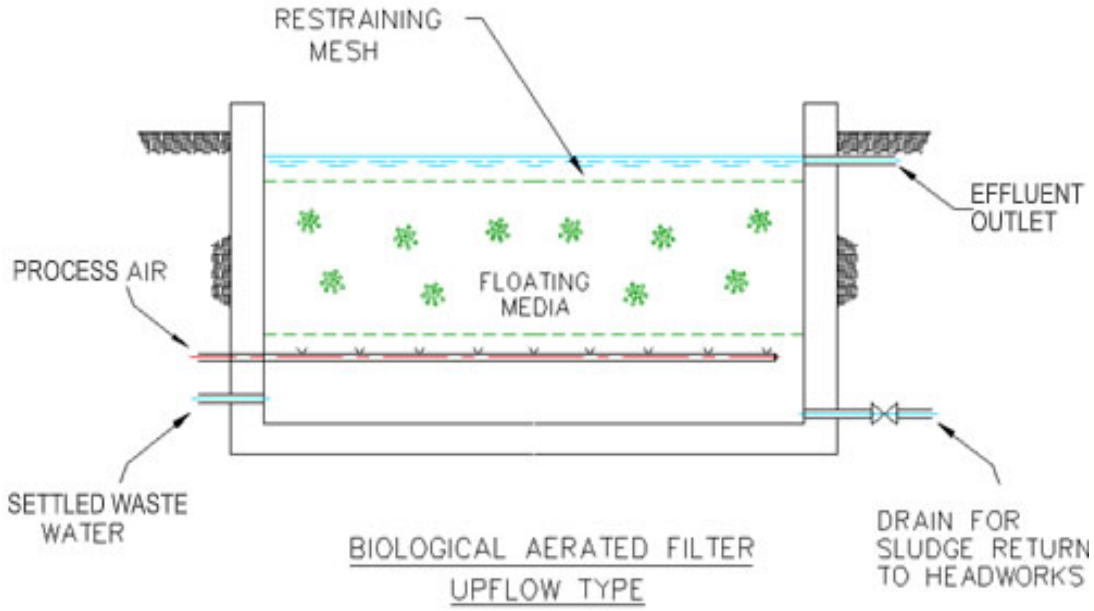
Water Treatment Plant (In Million Gallons)
Daily plant capacity – 144
Total treated, finished water - 88

Number of people served - 432,911

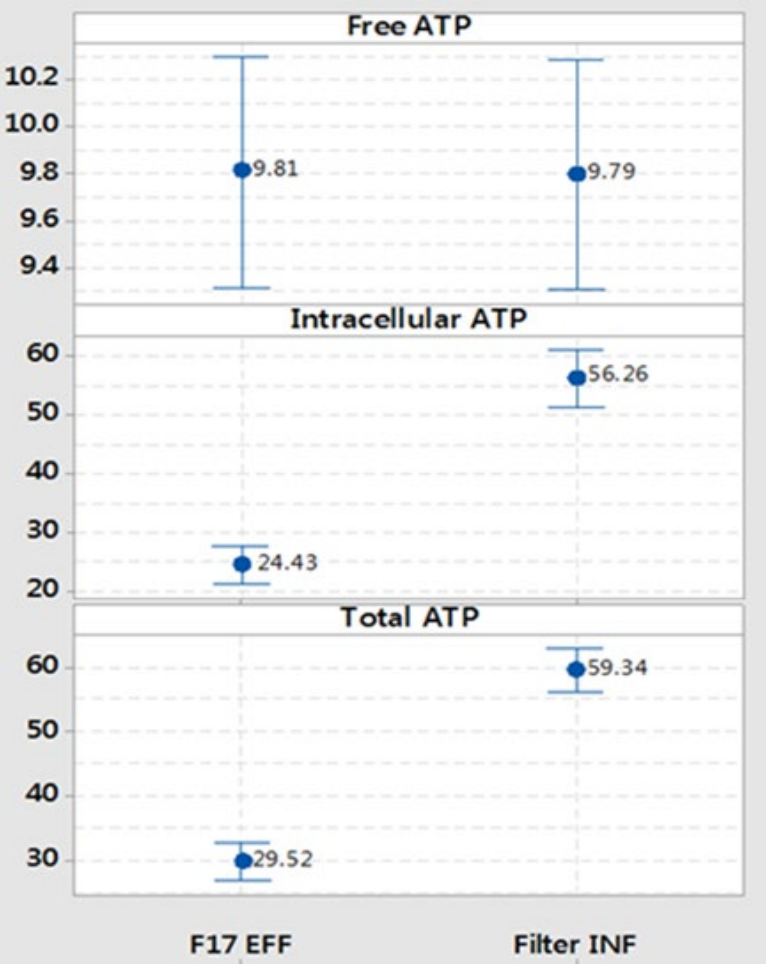
Optimization of a biological filter and plant risk mitigation

The objectives:

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



Field data: drinking water



The graph shown on the right is the statistical summary from analysis between June and September2017 regarding filter influent and effluent of a biological filter.

Filtration process is effective in removing ~57% of influent biomass based on the ATP data.

Data courtesy of Saint Paul Regional Water Services, MN, USA

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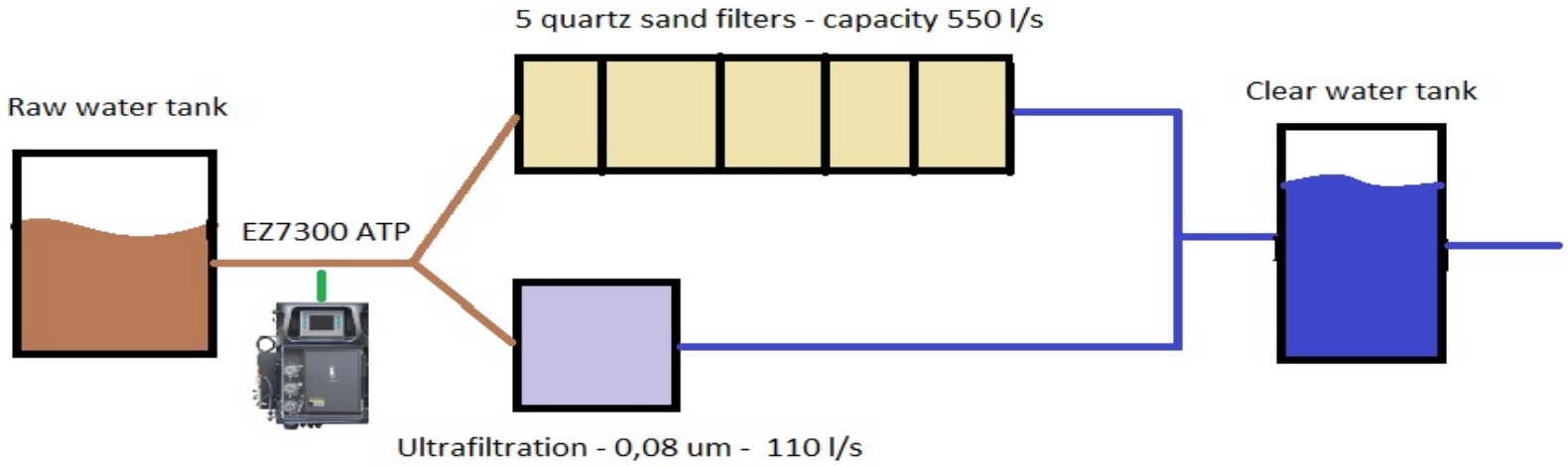
Drinking water production company senj, vodovod južni ogranak senj

- Water source for production of drinking water is accumulation from two rivers (Lika and Gacka).

- HE Senj - electricity power plant - also use this accumulation for electricity production. Maintenance plan - 3 times a year.

- Maintenance plan affect on quality of raw water, especially on turbidity and microbiology

Solution



- In normal condition customer use sand filter

- In case of microbiology excess customer will use ATP analyzer as early alarm and switch purification to ultrafiltration

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THANK YOU FOR YOUR TIME TODAY

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