Make water quality a part of your management culture

Mohammad Afrouziyeh, PhD

Research Associate

Poultry Innovation Partnership

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A farm story!

- There was a poultry farm that was experiencing poorer performance from flock to flock.
  - Gains down a bit
  - Feed conversion up a bit

Start with FLAWS

- Feed
- Light
- Litter
- Air
- Water
- Sanitation, Security, Space

Reason was found!

- The cistern was full of pseudomonas

- Action:
  - Between flocks –
    - Drain the cistern
    - Pressure washed it
    - Disinfected with Virkon

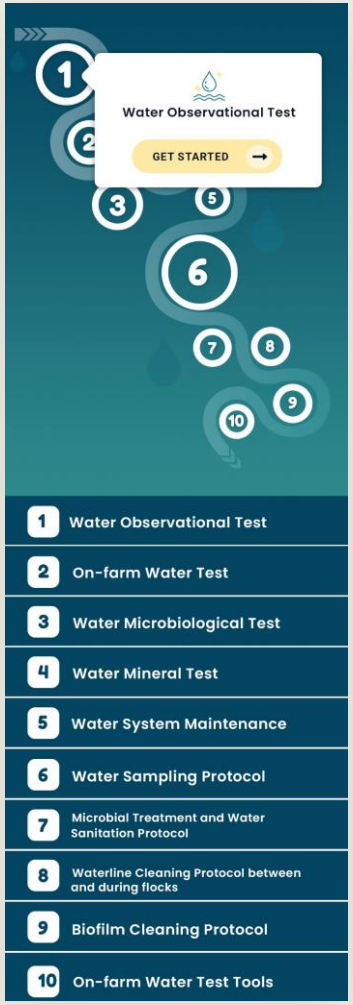
Results!!!

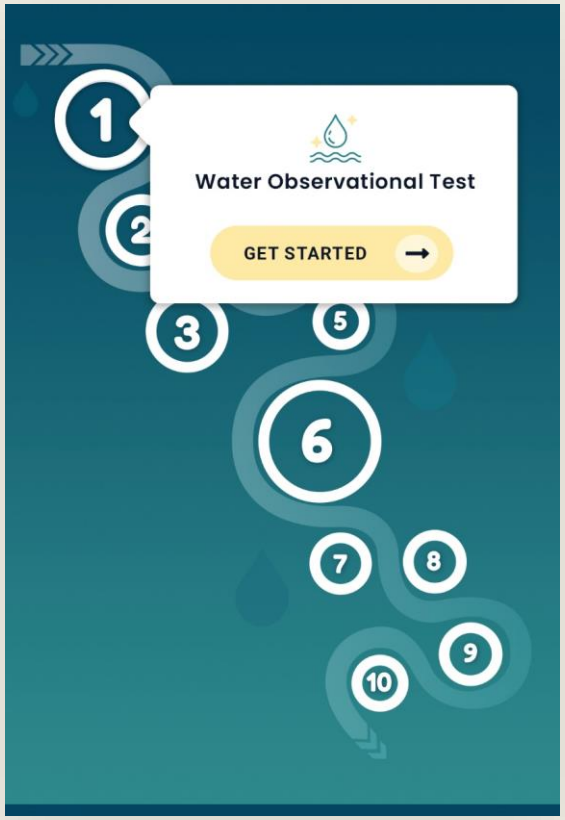
FCR went down by 0.14 from 1.78 to 1.64

Final weight went up from 2.07 kg to 2.65 kg

Return per bird went up from $2.25 to $3.37

Water Decision Tree App





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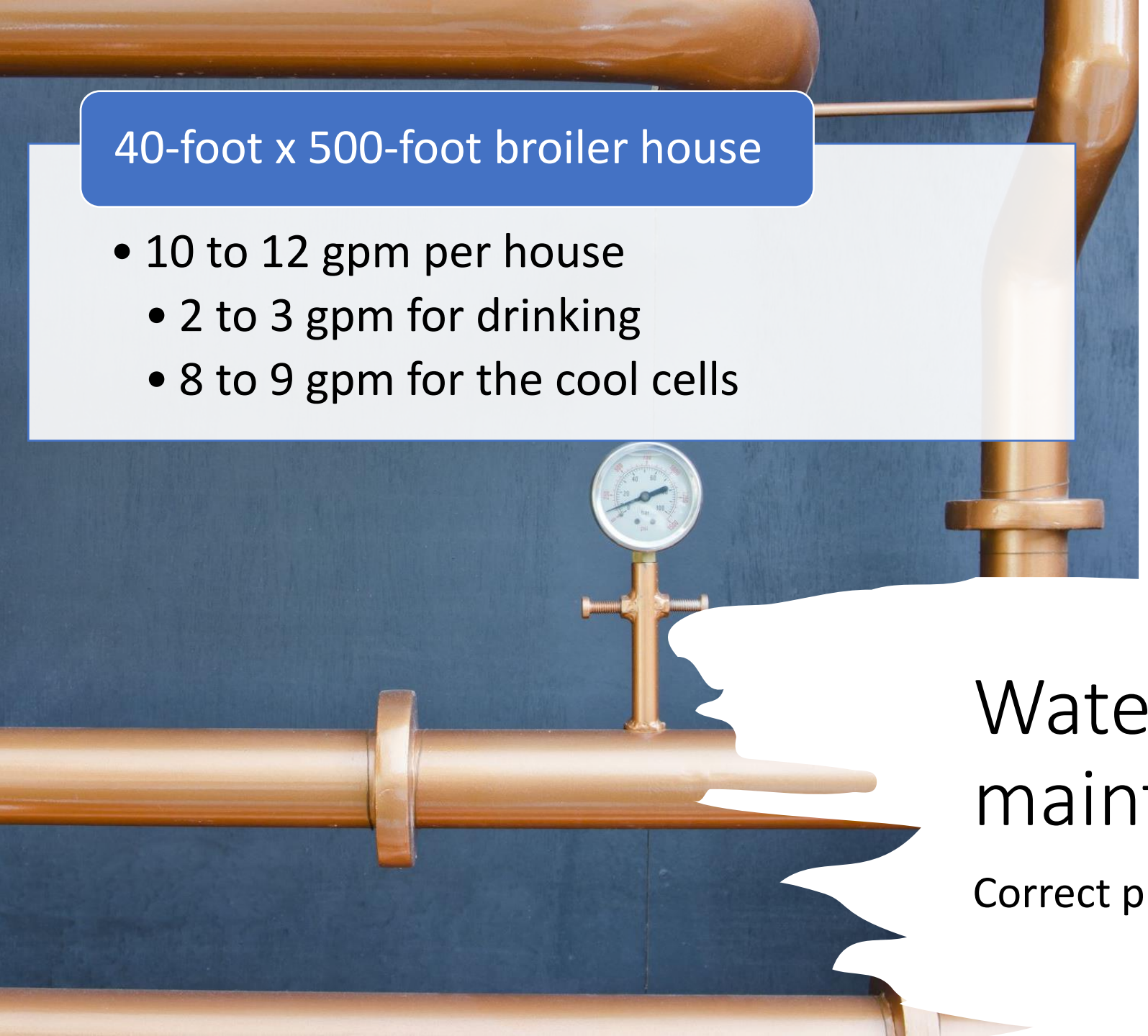
Factors affecting water quality

- Water system maintenance
- Water hardness
  - dissolved Calcium and Magnesium
- Microbial level
- pH
- Mineral content
  - calcium, magnesium, iron, manganese, sulfur, sodium
- Organic matter load

Checklist for water system maintenance

Photo credit: Proxy-Clean

Item to check	Frequency
Well-head/bore-head	Monthly or after any unusual events
Clear strainer for debris	Monthly or after any unusual events
water storage and header tank	Every 3 months • inlet and outlet screens Annually • structural conditions, sludge level, and internal cleanliness
Check and replace the filters	• Based on manufacturer's advice • Earlier if a decrease in water flow is noticed
Test pH level after filters	Monthly
Check the drinkers for any leak or malfunction or sagging	Daily
Check inside the regulators	Between flocks/bimonthly
Water flow rate in nipple drinker	weekly
Standpipes	regularly



40-foot x 500-foot broiler house

- 10 to 12 gpm per house
  - 2 to 3 gpm for drinking
  - 8 to 9 gpm for the cool cells

Flow Rate	Pipe Size
5 gals/min or less	3/4"
10 gals/min or less	1"
20 gals/min or less	1 1/2"
40 gals/min or less	2"
60 gals/min or less	2 1/2"
80 gals/min or less	3"

Water system maintenance

Correct piping size

Confined area for young chickens during brooding

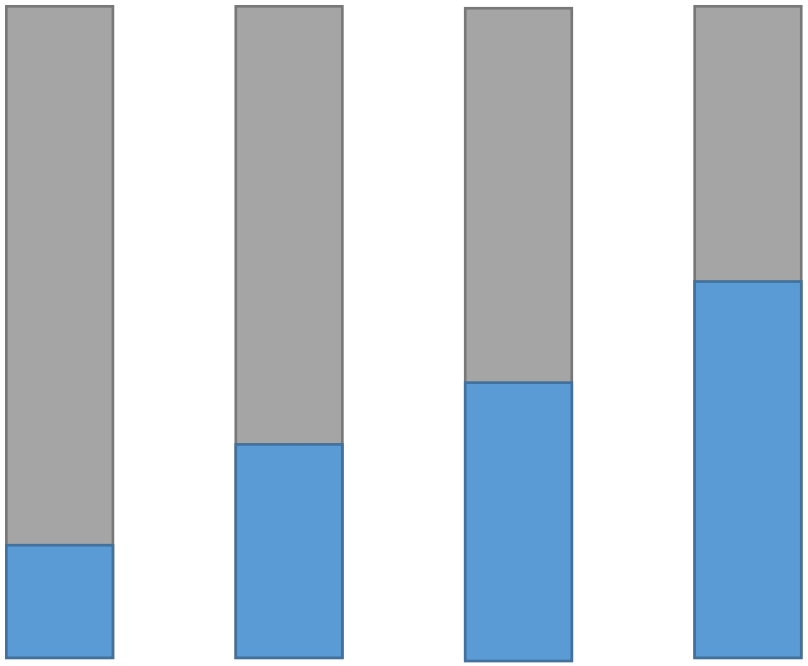
Flush the off-brood end lines very well before turning out the birds

Water flow rate in nipple drinkers

- Nipple type
  - 180 degree for breeders
  - 360 degree for broilers
- Ensure drinker lines are level
- Drip cup cleaning

Bird age	Flow rate
0 to 7 days	20 ml/min
7 to 21 days	60 to 70 ml/min
> 21 days	70 to 100 ml/min

Inspect the standpipes quantitively and qualitatively



Video credit to Dr. M. Abdollahi

Inspection camera to look inside the water lines for any problems

Photo credit: Proxy-Clean Products and WATTPoultry.com

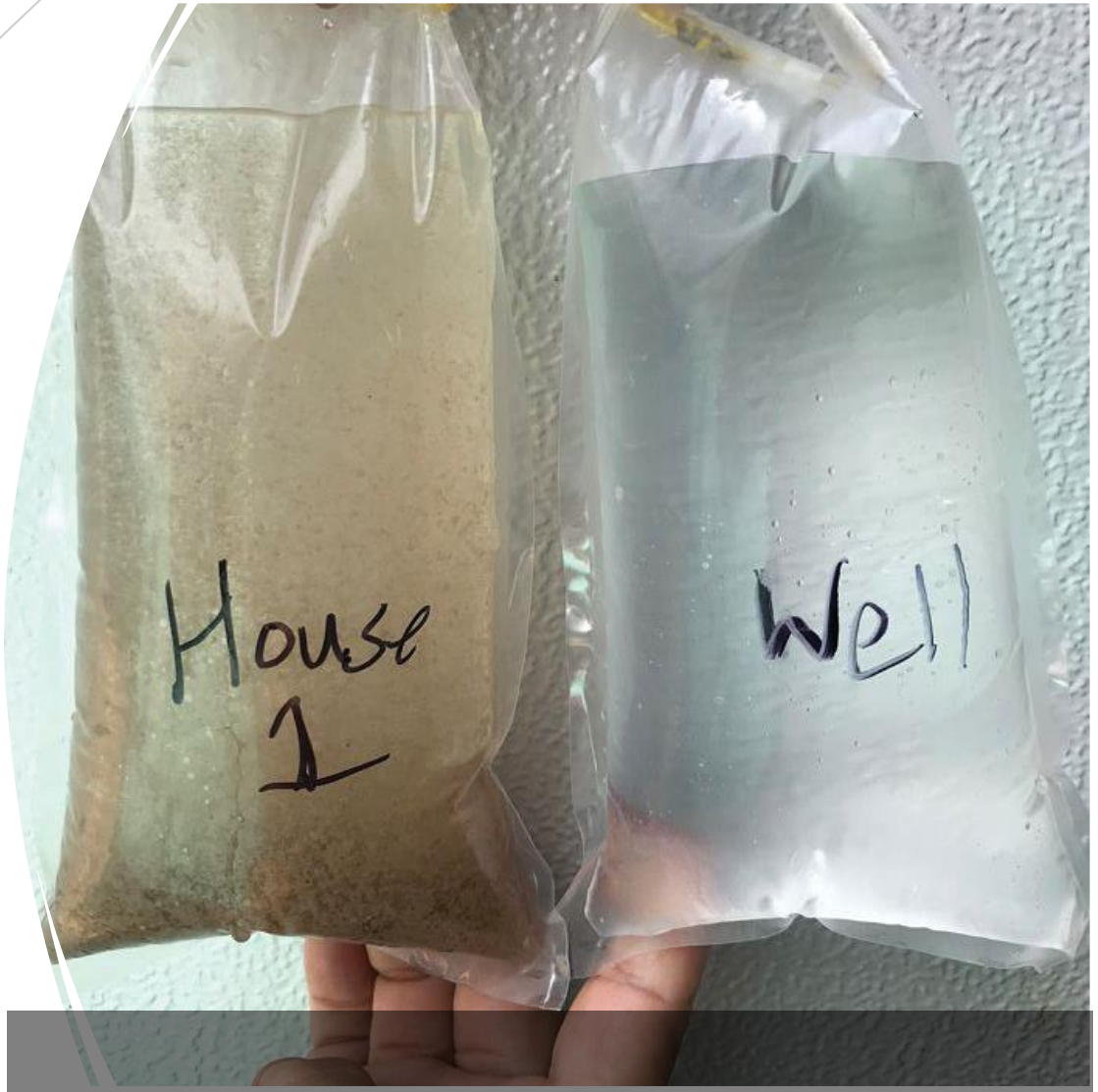


Photo credit: Dr Susan Watkins lab and WATTPoultry.com

Compare source water with end of line water

Why water test?

Information for diet formulation

ROI

(Return On Investment)

Decreased condemnations

Reduced FCR and mortality

Removing subclinical disease

Minimize and optimize water treatments

Piece of mind

Water test

On-farm tests

- Color, taste, odor
- Turbidity (suspended solids in the water)
- Oxidation-Reduction Potential (ORP) test
- pH test
- Chlorine test

Lab tests

- General water analysis
  - Water lab
    - Water pH, Total bacteria, and coliforms
  - Diagnostic lab
    - specific microbial test such as Pseudomonas, or Pneumovirus
- Mineral test

ORP & pH test

- Objectives
  - To ensure that water has optimum sanitizing value and quality for the birds
  - Identifying water supplies that don’t have an adequate chlorine residual
  - Adjusting the residual without overusing chlorine
- ORP readings
  - ORP > 650 mV (acceptable)
  - ORP = 700 to 750 mV (most desirable)
  - Lower values of ORP (e.g., 250 mV)
    - a heavy organic load or the presence of reducing agents such as ferrous iron (Fe2+), manganese (Mn2+), bisulfide (HS-), and sulfite.
- pH = 5.5 to 7
  - Most effective for water sanitizers

Electrical conductivity (EC) test

A measure of the ability of water to conduct an electric current

Depends on the concentration of charged ions (e.g. salts) in the water

Acceptable level: less than 4.7 deciSiemens per meter (dS/m)

TDS (mg/L) = EC × 640

(where EC from 0.1 to 5 dS/m)

TDS (mg/L) = EC × 800

(where EC > 5 dS/m)

TDS: Total Dissolved Solids

Pool test strips

- Water hardness
  - Carbonate hardness (temporary)
  - Non-carbonate hardness (permanent): *TBD by lab*
- Free chlorine
  - 2 to 4 ppm free chlorine
- pH
- Total alkalinity

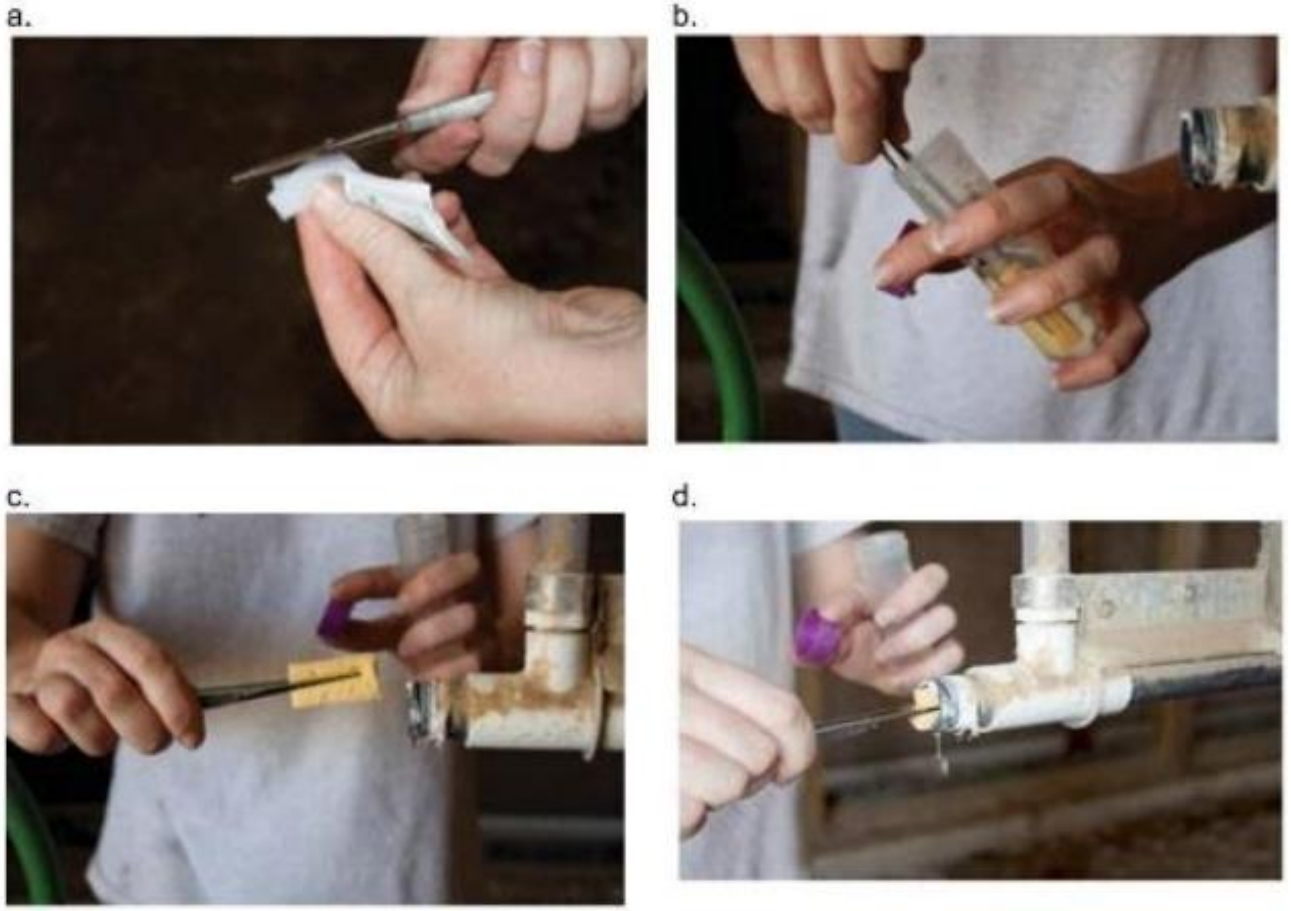
Water drip sampling

- Label sampling bag
- Sterilize tweezers
- Trigger the drinker to collect sample
- Roll and seal the bag

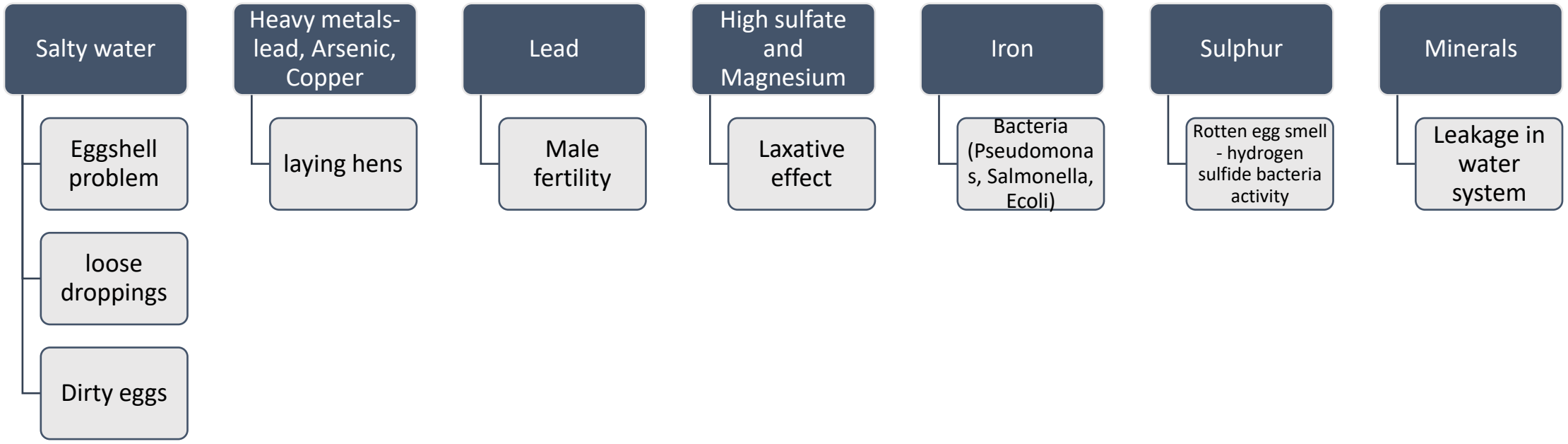
Austin et al., 2017

Swab sampling

- A) cleaning the tweezers
- B) removing the sponge to take swab sample
- C) inserting the sponge inside the water line
- D) taking a swab sample from the water line



Water mineral content



Steps for cleaning water lines from minerals

Oxidation with chlorine dioxide or hydrogen peroxides

Filtration

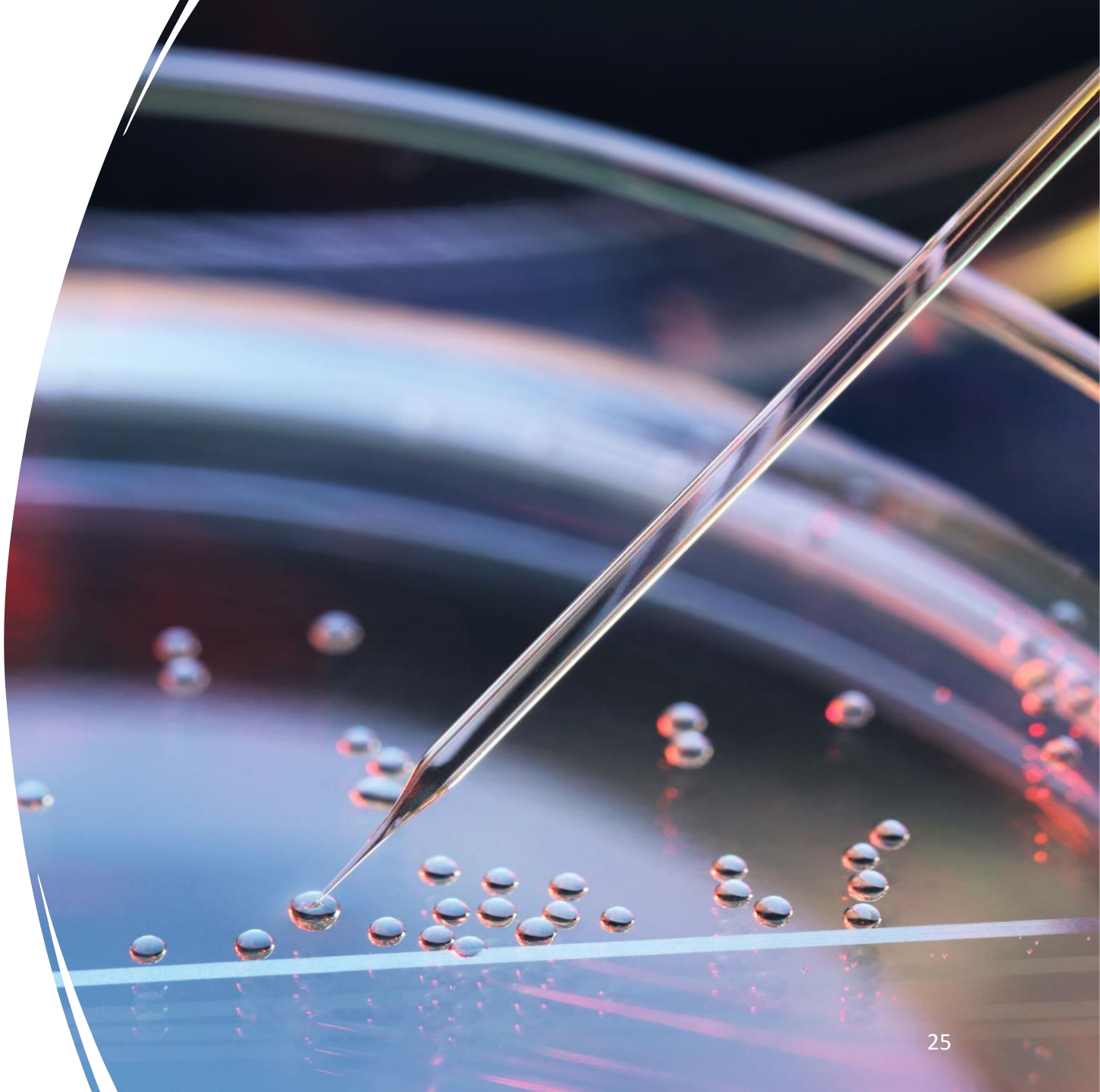
Acidification (Citric acid)

Water treatment

Iron X tank to reduce dissolved iron and manganese compounds from raw water supplies.
Source:https://www.aquascience.net/

1. Filtration
   - reduce or remove the solid particulates and microorganisms
   - prevent clog or drip in drinker lines and nipples
   - reduce pathogens in the litter
2. Water softener tank
   - remove calcium, magnesium, soluble iron, and manganese
   - Water passes through a synthetic material or resin called zeolite
3. Aeration
   - Pumping water into holding tank from the height
   - remove hydrogen sulfide
   - reduce dissolved carbon dioxide as well as oxidizing iron and manganese
4. Reverse Osmosis
   - Forcing water through a series of membranes by high pressure
   - reduce sodium, chloride, and nitrates in water

Water microbiology in poultry operations



How pathogens sneak into a water system?

Flooding	Septic system failures or contamination during water system repairs.	water usage can concentrate natural contaminants resulting in ideal levels to promote	Medicator buckets that aren't kept clean and covered	Well or water source	Storage tank
Underground lines (cracked especially if under the driveway)	Entrance room	Regulators	Water line in barn	Drinkers	Ventilation system
	Airborne from disturbed litter	Other living creatures in the environment	Deposited by the birds	Left from the previous flock	

Water microbiological test

Total Plate Count (TPC) of aerobic bacteria	• Less than 1000 CFU/ml
Total coliform bacteria	• Less than 50 CFU/ml
Fecal coliforms in the water	• Below detection (zero CFU/ml)
Salmonella and Pseudomonas in the water	• zero CFU/ml
“chlorophyll a” levels	• Less than 15 µg/L

CFU: Colony-Forming Unit

Water line sanitation

Steps to sanitize water line

1. Analyze water for any scale-causing minerals (carbonates or bicarbonates of Ca, Mg,

Fe and Mn), if high then use an acid to descale

2. Select sanitizer

- Chlorine solutions
- Chlorine dioxide
- Hydrogen peroxide

3. Prepare the distribution system for sanitizing

- Proportioners (to prepare 0.8 to 1.6%)
- Large tank for higher concentrations

4. Clean the lines

- 30–38 L of water to fill and clean 30 m of 20 mm water line

$$\frac{38\ \text{L}}{X=380\ \text{L}} = \frac{30\ \text{m}}{300\ \text{m}}$$

5. Remove mineral build-up

- Use citric acid to descale the line

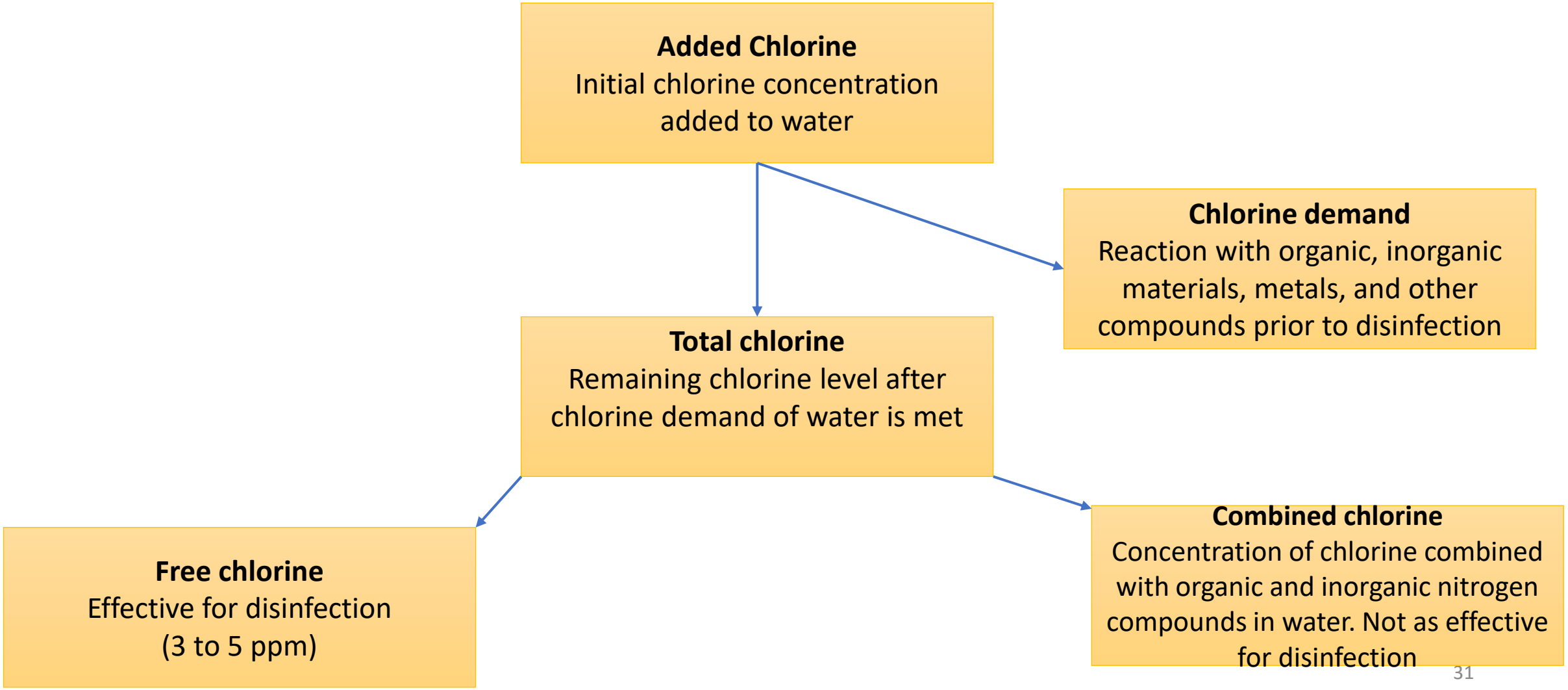
6. Keep the system clean

- Develop a good daily water sanitization program

Chlorine-based products are good if:

- Water pH is between 4 and 7
- Water contains low concentration of bacteria
- Water temperature is above 18°C .
- Water turbidity is low
- Exposure time is good enough
- Product is fresh with good storage condition
- Growth stage and type of bacteria can affect the effectiveness of the product

Chlorine addition flow chart



Chlorine dioxide and Hydrogen Peroxide

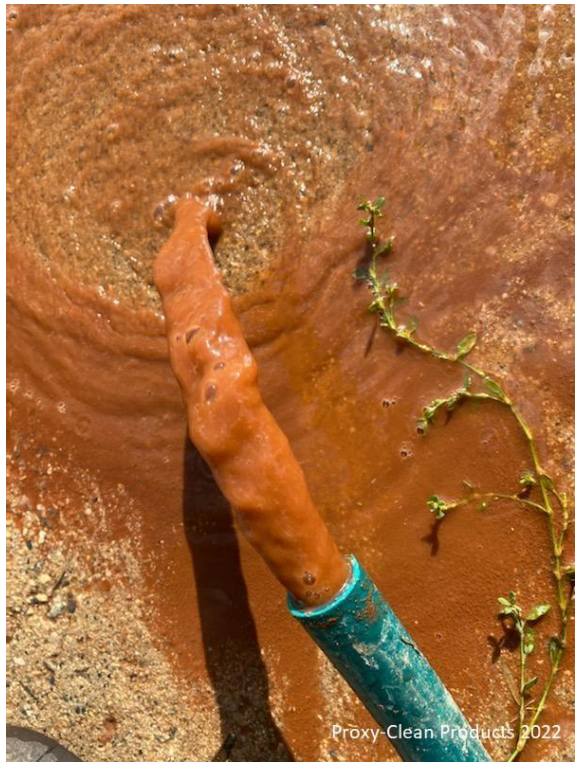
Can be used in water with pH>7

The end of line residual for free chlorine dioxide should be 0.5 to 0.8 ppm

The concentration of hydrogen peroxide at the end of the water line should be 25 to 75 ppm.

Flushed out materials

Iron



Mold

Photo credit to Proxy-Clean

Which acid should be used?

Acidified copper sulfate (most effective on reducing aerobic bacteria, yeast, and mold counts at pH = 4)

(Dean et al., 2008)

Citric acid

Sodium Bisulfate

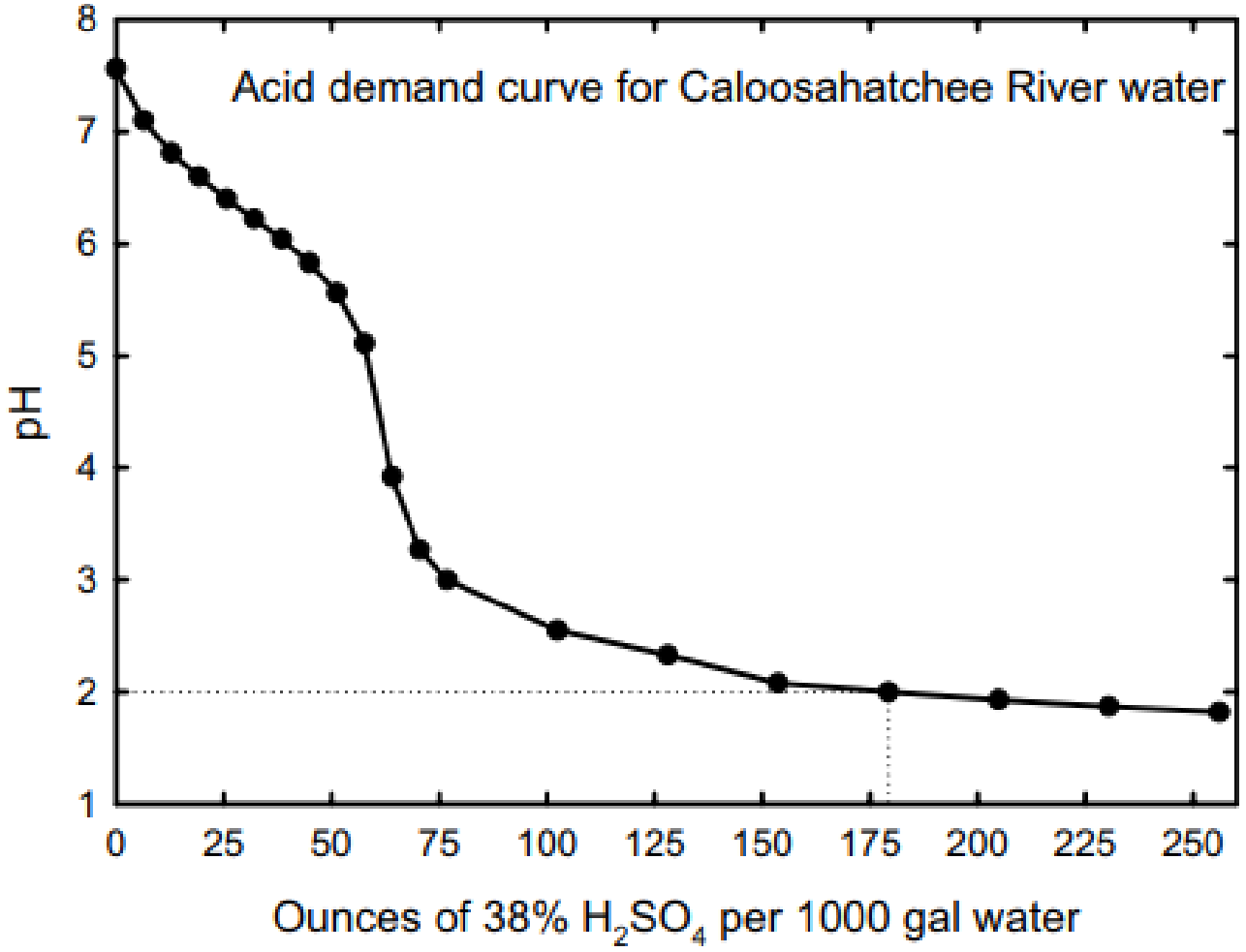
CID 2000TM acidifier (H_2O_2+ peracetic acid)

The right acid will be different for each farm based on the water hardness

Need to do an acid titration test on the water

Which acid should I use?

- Acid titration method to determine how much acid is needed to lower pH by one unit
  - This amount depends on water **hardness**
  - Economic comparison between acids
- Microbiological test



Graph adapted from: Thomas Obreza, 2011

Cleaning water tanks

Drain	Drain the water tank completely
Scrub	Scrub the interior to remove any dirt, sediment using a power washer
Rinse out	Rinse out the dirty water using cold water
Bleach	Bleach the interior using a 0.1% solution
Leave	Leave it for 4 to 6 hours
Wash and rinse out	Wash and rinse out thoroughly

Biofilm in waterlines

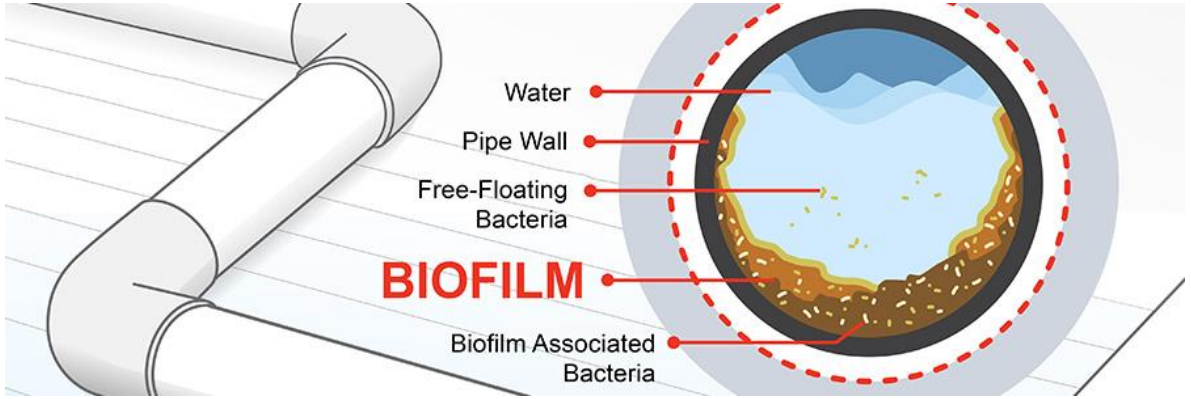


Photo credit to Proxy-Clean and https://www.flowguard.com/

Basic waterline biofilm cleaning

Acidify

- Acidify the water to a pH of 4 and let stand for 8 to 24 hours
  - Dissolve the mineral complexes in the biofilm and waterlines

Hydrogen peroxide

- Add hydrogen peroxide in a final concentration of 0.3 to 8% and let stand for 12 to 72 hours
  - Disrupt the organic component of the biofilm

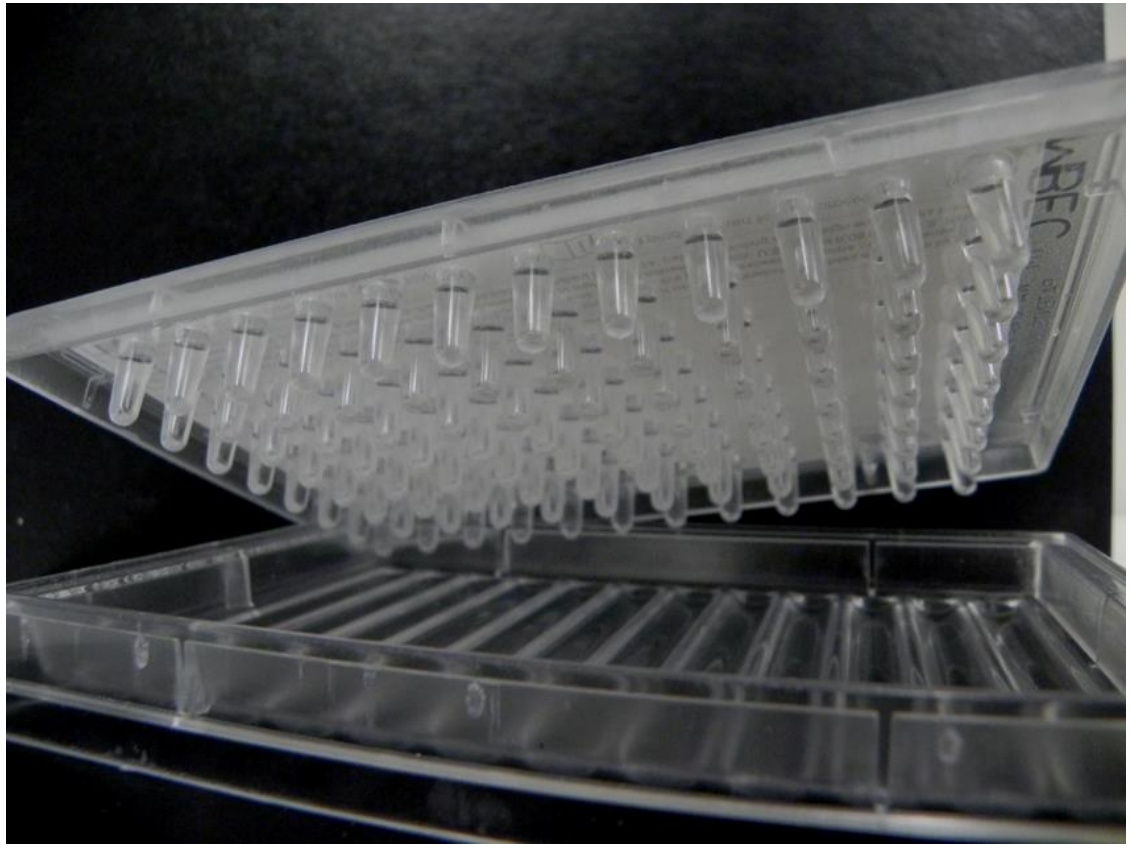
Disinfectant

- Add a disinfectant to kill the remaining microorganisms

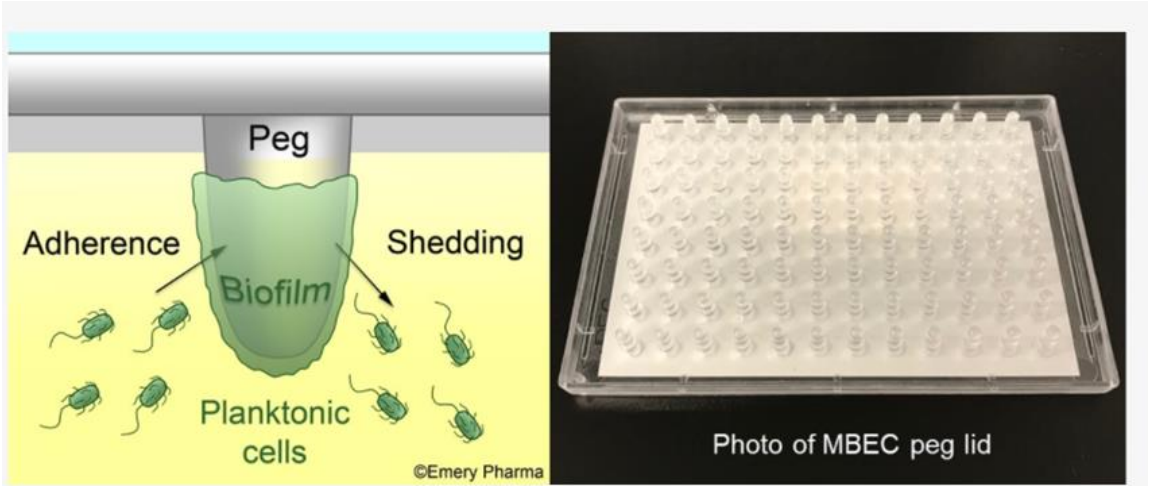
Flushing the system after biofilm treatment

What should we do with resistant biofilms?

Biofilm test kit

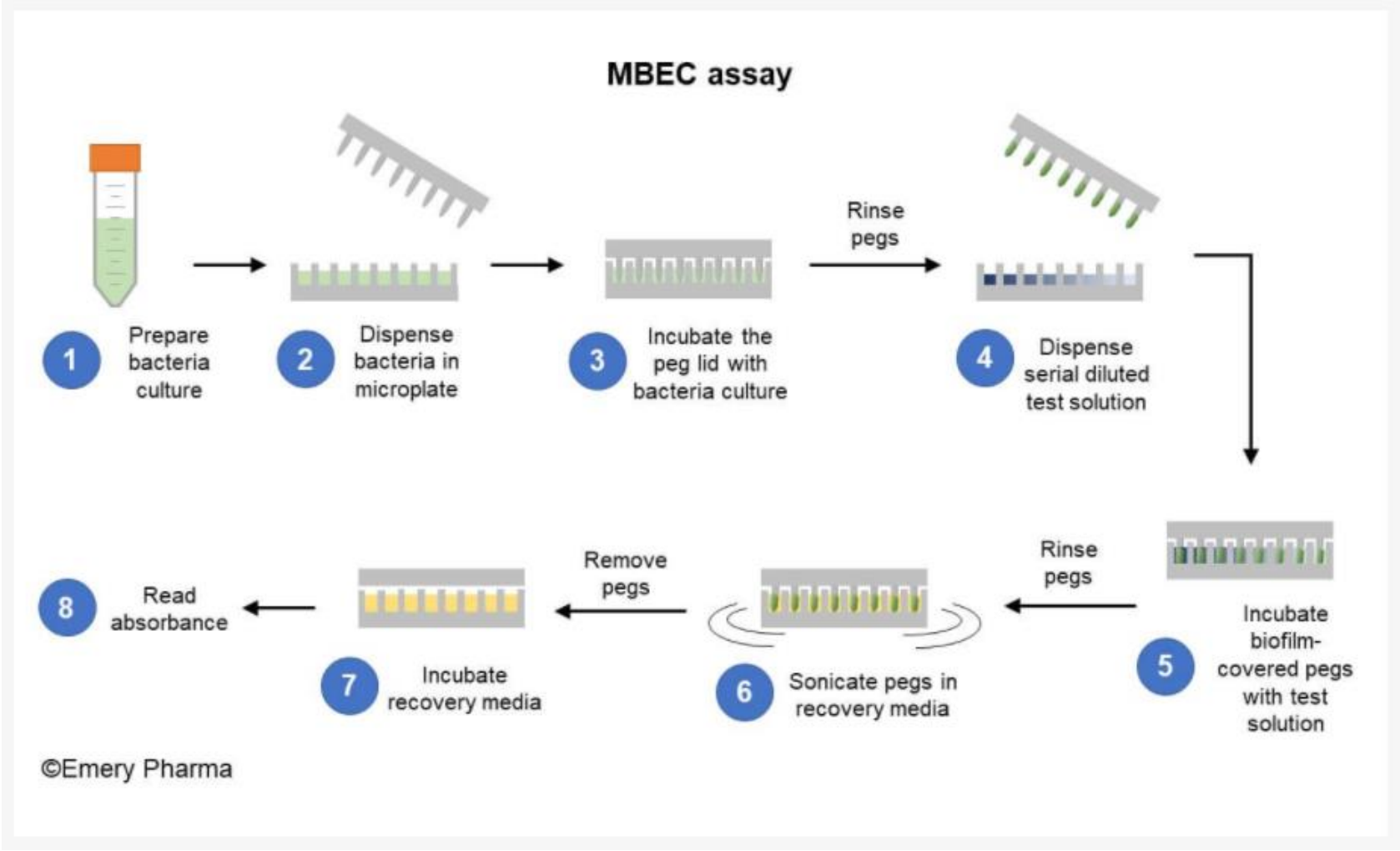


Recreate the biofilm in the lab and expose it to the potential disinfectants that we will be using in the farm



https://emerypharma.com/biology/biofilm-eradication

Biofilm Eradication Test

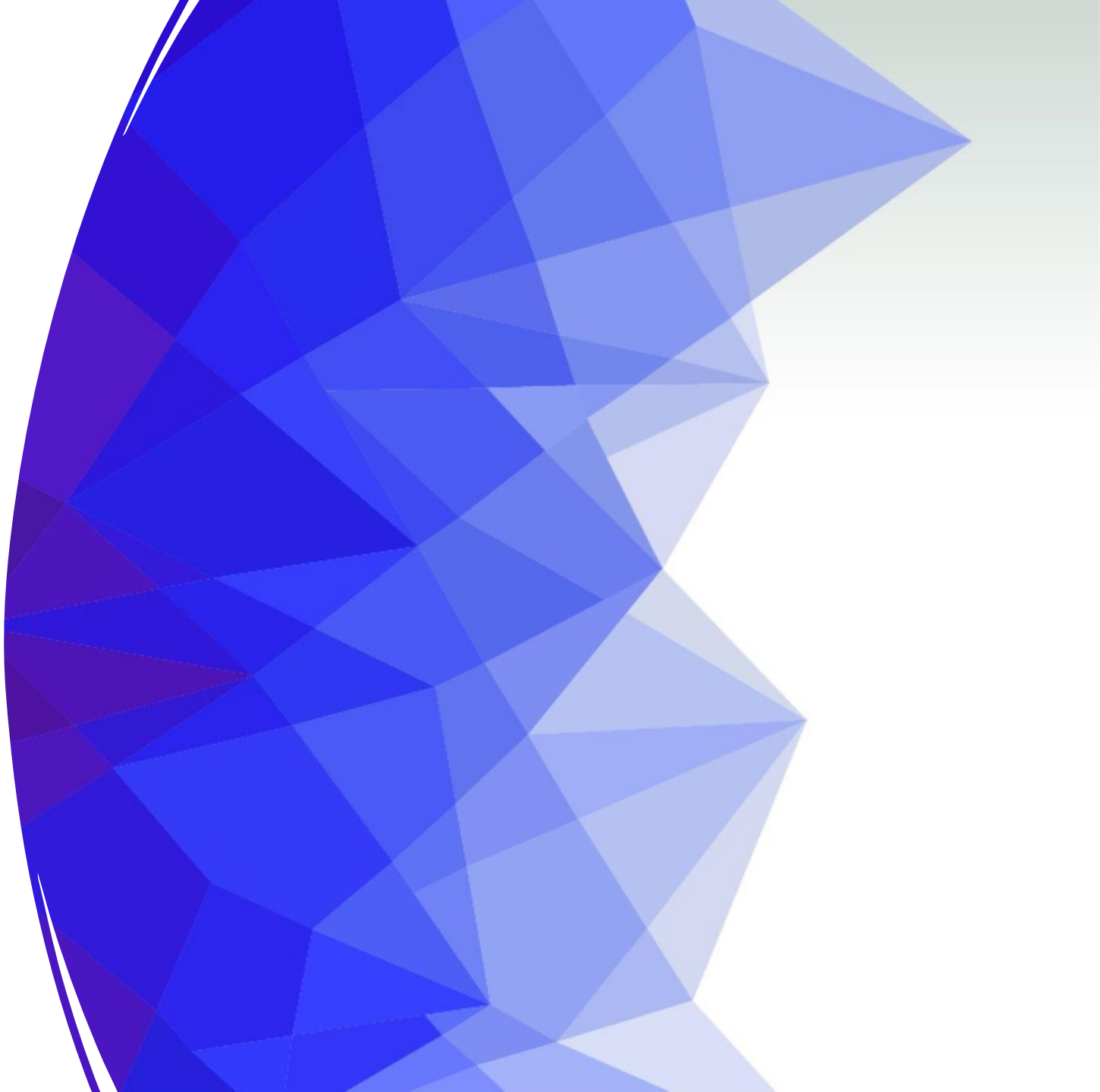


https://emerypharma.com/biology/biofilm-eradication

ASTM E2799-17, Standard Test Method for Testing Disinfectant Efficacy against *Pseudomonas aeruginosa* biofilm using the MBEC Assay, ASTM International, West Conshohocken, PA, 2017

Take home massages

- Never base major decisions on a single test
- Read and follow the instructions on the label and water line manufacture guidelines carefully before using any chemicals
- Add any new product to a sample first before proceeding to add to main drinker lines



THANK YOU
FOR YOUR ATTENTION