Managing Drinking Water for Optimal Flock Performance

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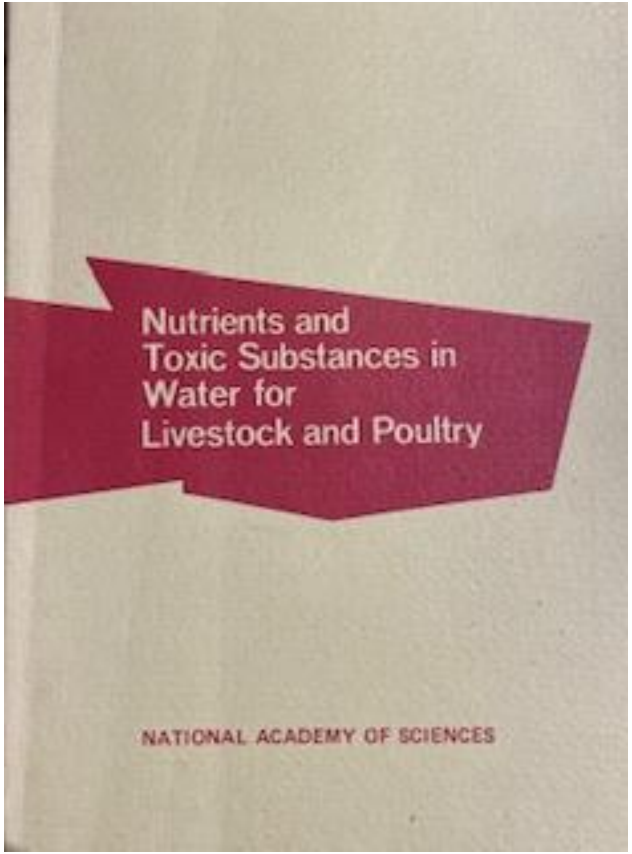
Fact:

Water is the
number one nutrient input
Compromising quality and quantity
increases risk for performance
challenges/lost revenue
The question is:
How do we know if it is compromised
and even more important, how can we
prevent it?

What We Know About Water

- Compared to feed, very little research in last thirty years that focused on water quality impacts
  - “Nutrients and Toxic Substances” (1971) excellent literature review of 60-80 year old research trials focused on nutrient tolerance levels
- In the 1980’s, significant work was done to identify correlations between water nutrients/contaminants and bird performance
- Then in the 1990’s, nipple drinkers introduced and combined with liberal use of antibiotics, the industry lost interest in water quality
- Poultry water standards most commonly referenced today evolved from human drinking water standards
  - Most MCL based on aesthetics not health
  - Exception-heavy metals-lead, arsenic, cadmium-those have health concerns
- Has the bird changed? Is this still acceptable practice?



Birds tolerant of most mineral contaminants

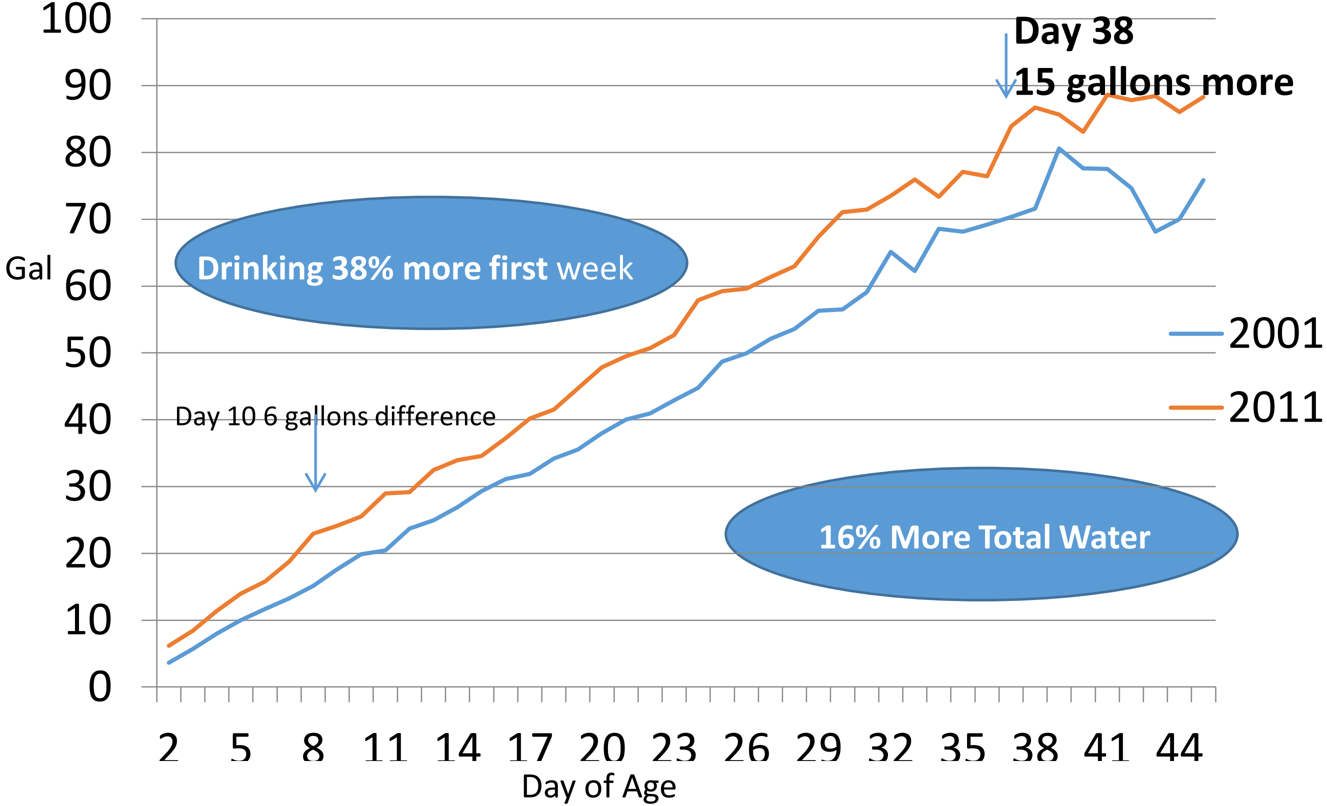
- Sodium and chloride-exception to the rule
  - Over 200 mg/l (same as ppm) loose droppings
  - Over 400 mg/l depressed weight gains, increased feed conversion, egg production issues
  - Can reformulate salt level in feed or use RO for salt removal
- Iron and manganese- birds tolerant of typical water levels
  - Birds less tolerant of the pathogens which utilize these minerals
    - Pseudomonas, E. coli, Salmonella
  - Sediment build-up causes water restrictions
- Calcium/hardness- pipe/drinker/cool cell restrictions greatest challenge
- Magnesium and sulfate combinations- loose droppings
- Alkalinity-sulfate bitterness-birds will self restrict
- Acid water-contains no buffering minerals-birds will self restrict
- No perfect pH (for performance)-alkalinity and acid dependent

Watkins Poultry Drinking Water Proven Points

- Control/prevent microbial contamination
  - The modern bird on antibiotic free programs has limited tolerance for water borne pathogens
- Assure the birds can get what they need, always
- Control the temperature
  - Even chicks do not prefer warmed water
- Proactive water system assessment and evaluation programs will pay for themselves

Modern birds require:
more water, are systems keeping up?

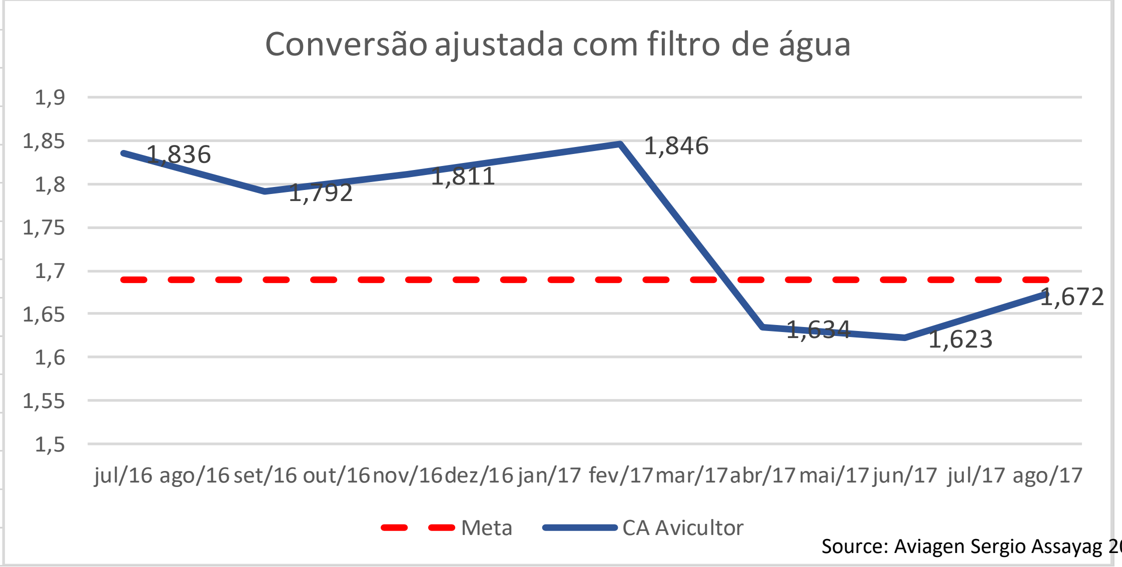
Water Usage/1000 Broilers



Water Quality can and does impact performance (Adjusted FCR)

- FCR improved with filter system, pH control and water chlorination
- Integrated grower “poor performer” close to being cut off

Mês abate	jul/16	set/16	nov/16	fev/17	abr/17	jun/17	ago/17
Meta	1,689	1,689	1,689	1,689	1,689	1,689	1,689
CA Avicultor	1,836	1,792	1,811	1,846	1,634	1,623	1,672



Source: Aviagen Sergio Assayag 2020

Is Water Temperature Important?

- Radiant heat sources warm surfaces-including drinker lines
  - Brooding/hot weather increases risk for slow moving water to elevate in temperature
  - Is this a problem for young birds?
- We assume mature birds do not prefer warm/hot water, what about new chicks?
- Conducted an experiment where broiler chicks received one of three water temperatures the first four days of brooding:
  - 40 F/4.4 C
  - 70 F/21.1 C
  - 100F/37.8 C
- Three pens each of 30 male broiler chicks were assigned to each water temperature treatment
- Water temperatures check every hour and adjusted to maintain goal
- On day 5, all treatments placed on same water which was close to 70F/21.1 C for rest of the flock life
- Chicks group weighed by pens on days 0, 7, 14

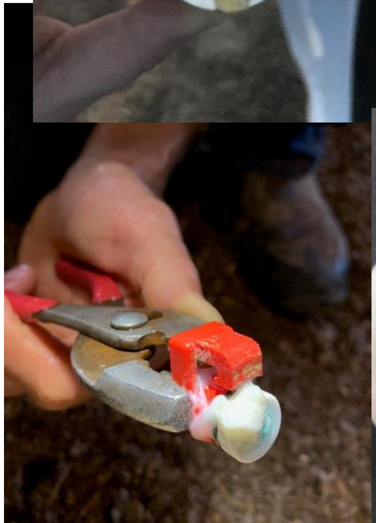
Impact of first 4 days drinking water temperature on broiler weights

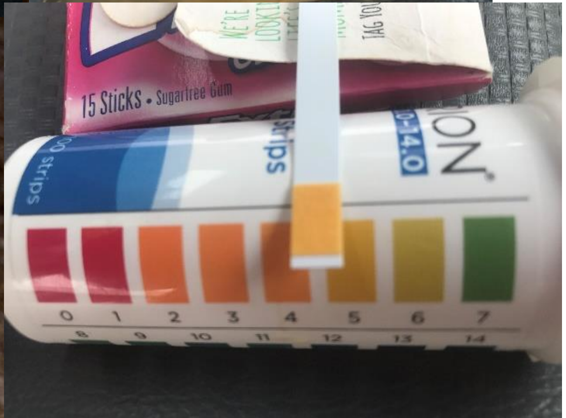
Temperature	Day 0 (grams)	Day 7 (grams)	Day 14 (grams)
40 °F/4.44° C	46.5	187	501
70 °F/21.1° C	47.4	188	501
100° F/37.8° C	46.7	167	463

By day 14- 37.8 ° C water birds behind 38 grams in weight
Key point we found-difficult to keep cold water, cold
Even chicks prefer cooler water
Thank you Cobb-Vantress for donating birds for project

Acknowledge water deserves careful attention

- Supplies are dynamic
  - Multiple factors influence quality
  - Quality can change
- Water supplies are unique
  - Source
  - Minerals, pH and microbes
- Operations are different
  - Storage
  - Distribution
  - Injection technology and location
  - Drinker type
  - Product usage
- Water promotes life-both good and bad
  - Pathogens continue to change and adapt
  - Pathogens take advantage of water systems





Implement a water system assessment program
Inspect what you expect

- Source
  - Changes?
  - Work done?
- Storage
  - Is it clean?
  - Is it cleaned?
  - Does sediment collect on bottom
- Injectors
  - Working correctly?
  - Meets demand?
- Water system sanitation
  - Cleaned between flocks?
  - Daily water product usage

Water is Perfect Carrier of Health Challenges

- Poultry drinking systems easily contaminated
  - Water slow moving/warmed
  - Water lines have many hiding places-pinch points
  - Water often contains food the organisms need
  - We add food-vitamins, organic acids

Water Supplies
Dynamic and Influenced by Many Factors

- Can change from season to season
- Droughts and floods
- Agriculture, industry and septic systems
- Well depth and placement
- Rock and soil it passes through
- Usage level

- **Surface water supplies most vulnerable**
- **Document quality-test for minerals, pH and bacteria**

Filters and Injection Points

- **Injection area/buckets sanitary?**
- **Are filters clean?**
    - **Sediment build-up invites microbes**
    - **Dirty filters block flow**






Verify Injection Technology

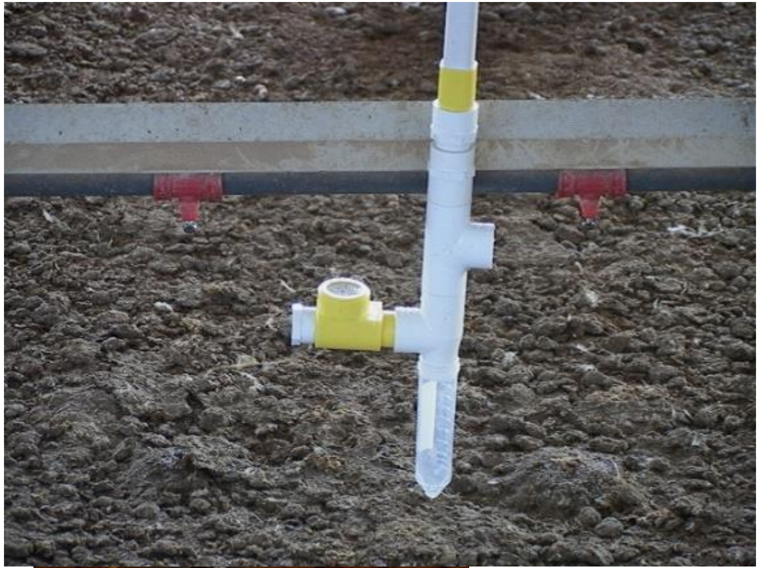
- Confirm injectors add products uniformly
- Confirm injectors do not restrict flow
- Assess if injectors “dump” or “blend”
- Do injectors cause products to “fight each other”

Is there enough water?

- RainWave available at Amazon.com ~$35 USD
- Can be used to check gallons/liters flow
- Confirm injector accuracy

Monitor Drinker Flow

- Check water flow from drinkers to confirm proper static flow rates for drinker type
  - Measure ml/minute
  - Check in different areas
- Water regulators can become hardened and result in failure to regulate pressure



Go inside
the water system
with an inspection
camera

Conduct Water Tests

Annual testing

- pH and mineral content
  - Source
  - Post treatments- filtration, sanitation
- Microbial
  - Total bacteria, E. coli, coliforms
  - Yeast and molds
  - Test the source and where birds are drinking

As Needed

- Assess product impact on quality
- Evaluate efficacy of disinfectants

Checklist for Water Mineral Analysis

- pH
- Minerals
  - Sodium
  - Chloride
  - Iron and manganese
  - Calcium and magnesium-Hardness/alkalinity
    - Bicarbonate (HCO3)
  - Nitrates/nitrites
  - Sulfur-sulfates
  - Silicon
  - Heavy metals-lead, arsenic, copper

Mineral Challenges

- Iron, manganese
  - Promote pathogens
  - Clog filters
  - Fill pipes with sediment
  - May never have problems but if health challenges show up on a farm and these minerals are present-first response should be a solid water sanitation program
  - Will need sanitizer and filtration to remove
- Sulfate-Sulfur
  - Rotten egg smell-hydrogen sulfide-shock chlorinate well, use water sanitation
  - Gray ‘paste”-clogging filters-hydrogen peroxide and then filter
  - Sometimes sulfur will “gas off” so may need to have vent

Filtration-Necessary Post Oxidation for Iron/Manganese or Sulfate Removal

- Farm Guard or Big Bubba
- 10 to 120 GPM
- Pleated filter
- Capacity of 180 string filters
- Can be washed, reused
- Casing will not dent, rust, chip or corrode
- Contact time
  - (20 minutes, pH 7-7.5) to precipitate iron
  - pH 7.5-8 and longer contact time to precipitate manganese

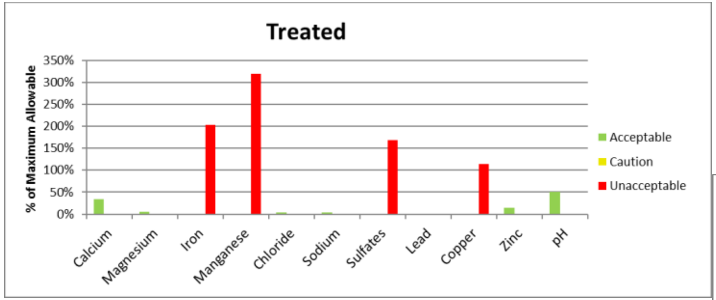
Iron X Filtration System

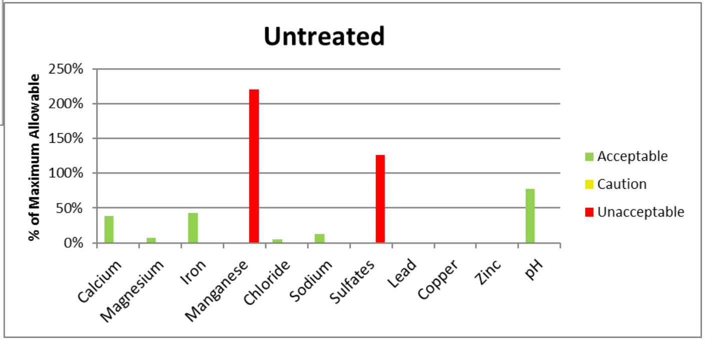
- Best for water with iron, manganese and/or sulfur
- Can program filters to back flush during low demand
- Chlorine keeps the proprietary resin filter bed charged so does not have to be replaced

- Proper oxidation and filtration should NOT let mineral through
- If you mineral deposits post filtration, something is not right
- In this case filter was not properly charged with an oxidizer for activation when installed

Check Pre and Post Treatments to verify Treatments are doing what they should

Farm 9	Calcium	Magnesium	Iron	Manganese	Chloride	Sodium	Sulfates	Sulfur	Lead	Copper	Zinc	pH
After Cl & Filter												
Treated	36.7	7.12	0.61	0.16	6.51	6.41	337.87	113	N.D.	0.68	0.22	4.1
Untreated	42.6	8.95	0.13	0.11	6.61	18.20	251.45	84.1	N.D.	N.D.	N.D.	6.24
Unacceptable Levels	121	137.5	0.33	0.055	165	165	220	220	0.055	0.66	1.65	8





Hardness/Alkalinity

- Hardness-Calcium and magnesium
  - Birds very tolerant ~250 ppm
  - Primary concern is mineral deposit on equipment and pipes
- Alkalinity-Refers to the amount and types of chemicals that can shift pH > 7
- Usually expressed as calcium carbonate ($CaCO_3$)
- Also dependent on bicarbonate, (HCO_3), and sulfate (SO_4)
- Poisons in nature usually alkaloid so if high alkaline (sulfates) back birds off water

Monitor Cool Cell Recirculation Tanks
Need extra management with hardness issues

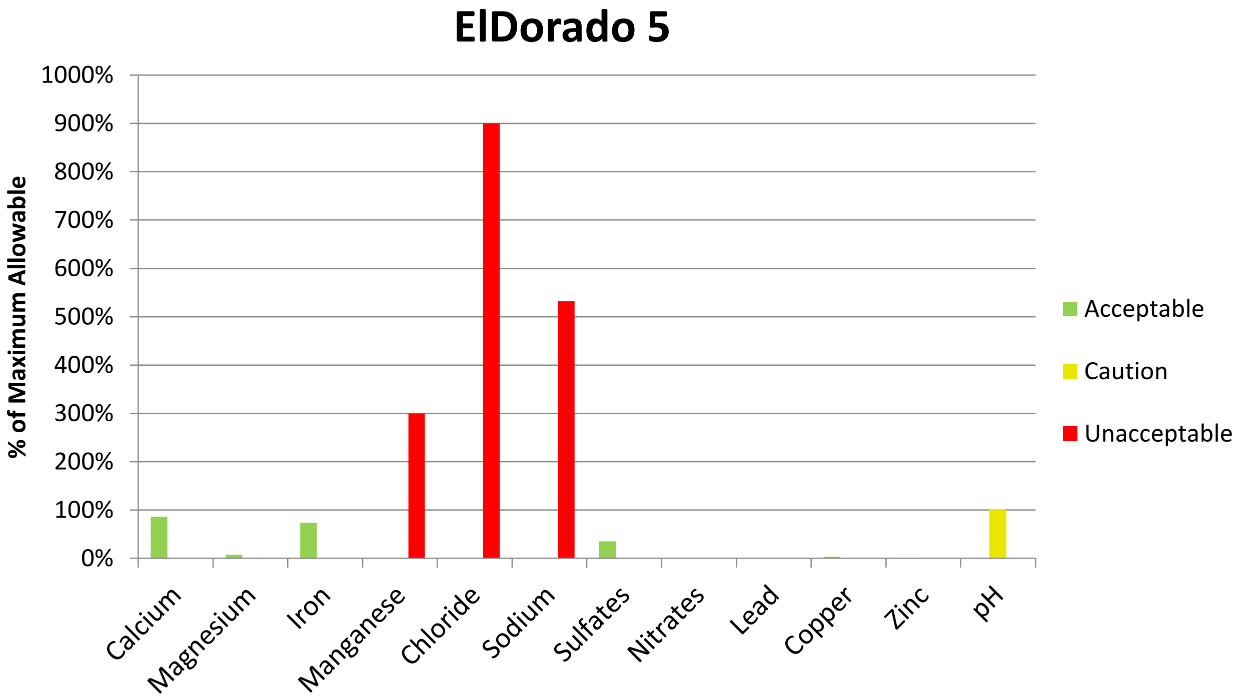
Water Sample	Iron	Copper	Calcium	Sulfates	Sodium	Chloride	pH
Well	0.05	.01	28	5	46	228	8.63
Recirculation Tank	0.29	.07	7.54	439	126	2302	9.88

As water evaporates, it concentrates minerals in recirculation tank and increases pH and elevated pH causes calcium to precipitate out on pads

What to do about Hardness

- Acidify drinking water
  - helps keep Ca in solution
  - Can help mask alkalinity taste concerns
- Use a sequestering agent
  - Keeps Ca in solution
  - Polyphosphate products prevent scaling
- Water softener
  - Exchanges sodium for calcium
  - Not a good option for water already high in sodium

Some issues must be fixed to prevent production challenges



Impact of Reverse Osmosis on Water Contaminants

	Na	Cl	Fe	Mn	pH
Pre	367	232	.02	.01	7.56
Post	3	4.47	nd	nd	6.34

RO water is very aggressive and needs neutralizing to prevent damage to metal components and prevent birds backing off consumption

Blend RO Water with Raw to Optimize Quality and Quantity

This will also help reduce the waste stream

	Calcium	Chloride	Hardness	Iron	Mg	Mn	Mo	Nitrate	pH	P	K	Sodium	Sulphate	Zn	TDS
Pre RO	**200**	**155**	**581**	**0.445**	**38.7**	**<0.10**	**<0.02**	**<0.5**	**7.3**	**<0.04**	**5.87**	**127**	**520**	**<0.04**	**1180**
Post RO	**0.53**	**6.1**	**17**	**<0.10**	**0.117**	**<0.10**	**<0.02**	**<0.5**	**5.5**	**<0.04**	**0.303**	**5.49**	**<5.0**	**<0.04**	**<20**
10% Blend of Pre with Post RO	**30.8**	**29.4**	**103**	**<0.10**	**5.98**	**<0.10**	**<0.02**	**<0.5**	**6.2**	**<0.04**	**1.15**	**27.9**	**90.8**	**<0.04**	**162**

Natural Low pH Water Needs Neutralizing Not More Acid

Sample ID	B	Mg	Ca	Mn	Fe	Ba	S	Na	Cl	pH
Farm A	0.09	1.54	4.74	N.D.	0.02	0.07	3.53	3.38	0.12	3.79
Farm A	0.23	1.49	4.32	0.01	0.01	0.07	8.97	7.65	N.D.	3.71
Farm A	0.08	1.54	4.36	0.02	0.02	0.07	2.94	2.74	N.D.	4.60

Acid water common in sandy soil areas

Symptom-Low weights, high feed conversion but good livability, poor water consumption

Diagnosis-water with low pH , no natural buffering

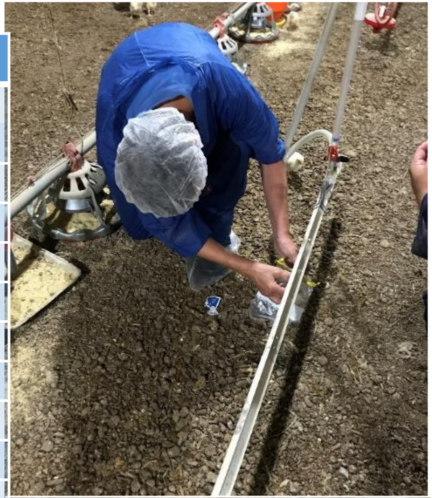
Solution: Neutralize with sodium bicarbonate/carbonate

Collect Samples from source and drinkers
Total Bacteria
Inexpensive Quality Assurance Test
(>10,000 cfu/ml-potential for problems)

Farm	Source	End of Line in Poultry Barn
	colony forming units of Bacteria/ml	
A	2,700	26,600
B	203,000	2,340,000
C	0	4,775,000
D	0	0

Assess how products influence quality

Specimen	Genus/Species	Result	Level
Water		Mixed aerobic culture	4+
	Bacillus sp.	Cultured	4+
Water		Mixed aerobic culture	4+
	Escherichia coli	Cultured	2+
	Pseudomonas aeruginosa	Cultured	3+
	Staph. coagulase Negative	Cultured	3+
	Alpha Streptococcus species	Cultured	2+
Water		Mixed aerobic culture	3+
Water		Mixed aerobic culture	4+
	Pseudomonas aeruginosa	Cultured	2+
Water			
	Klebsiella sp.	Cultured	1+
	Bacillus sp.	Cultured	2+
	Staph. coagulase Negative	Cultured	3+
Water		Mixed aerobic culture	4+
	Staph. coagulase Negative	Cultured	4+
Water		Mixed aerobic culture	2+
	Staph. coagulase Negative	Cultured	2+



Line Swab Procedure

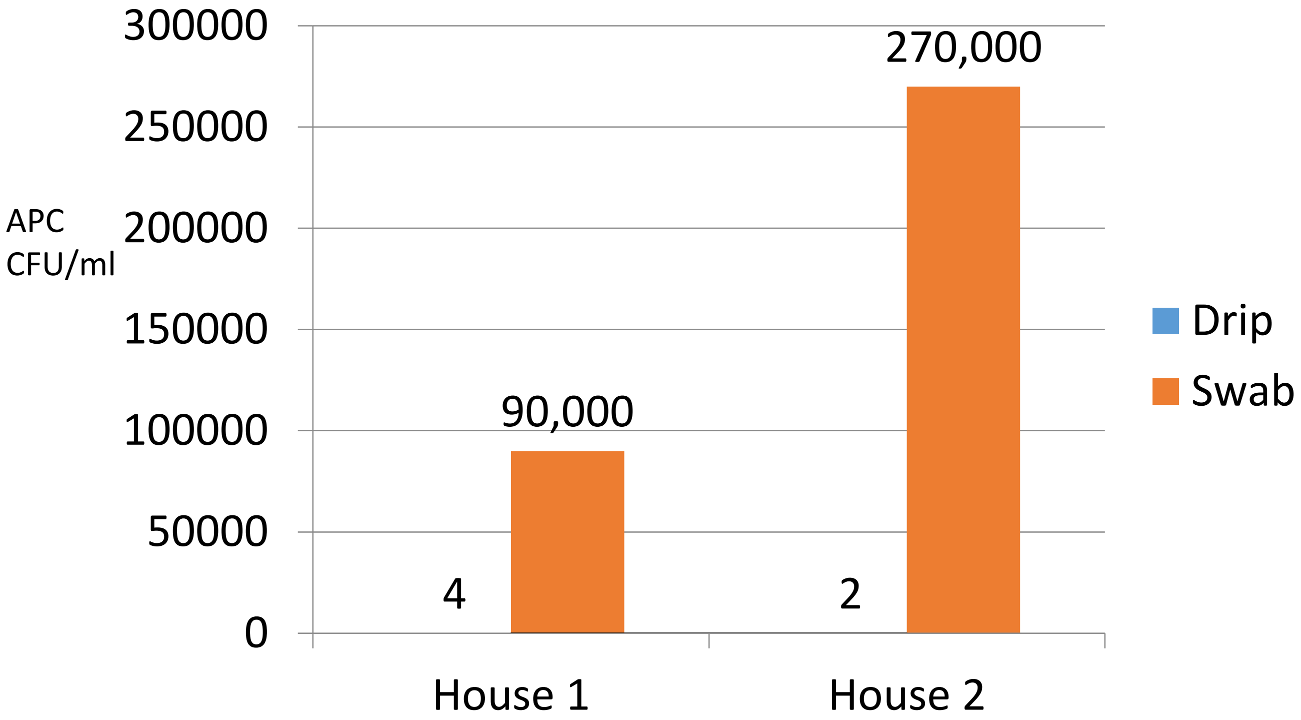
Drip sample may not always reflect what's present in the lines-swab inside of the line at end of line

PUR-BLUE™

Large Swab for Qualitative Testing, 100/case	Item Number
HiCap Neutralizing Broth, 1.5 ml	BLU-HC-P
D/E Neutralizing Broth, 1.5 ml	BLU-DE-P

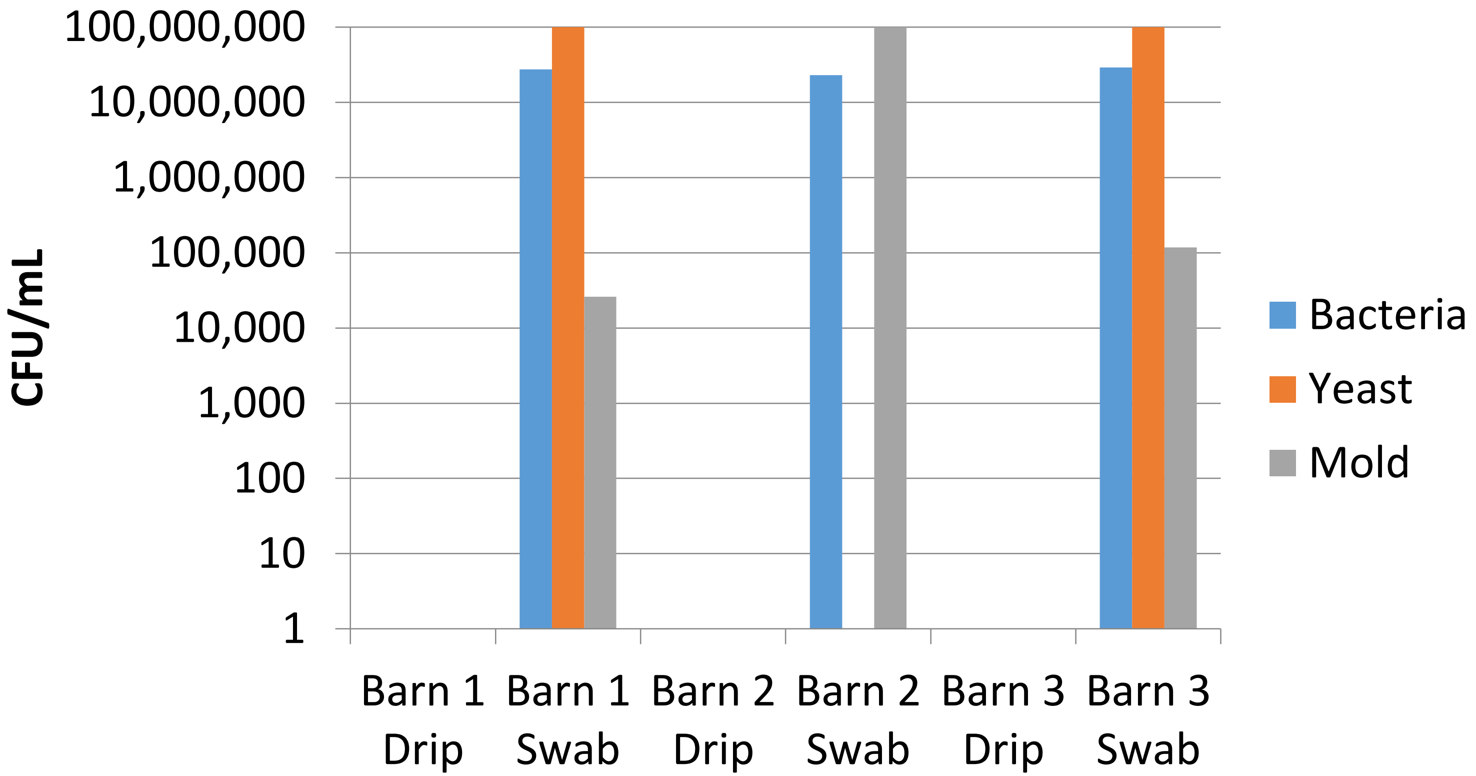
Large Swab for Quantitative Testing, 100/case	
HiCap Neutralizing Broth, 5ml	BLU-5HC
HiCap Neutralizing Broth, 10 ml	BLU-10HC
Letheen Broth, 5 ml	BLU-5LET
Letheen Broth, 10 ml	BLU-10LET
Neutralizing Buffer, 5 ml	BLU-5NB
Neutralizing Buffer, 10 ml	BLU-10NB
Dry swab – *for wet surfaces or add preferred solution*	BLU-DRY

Drip Versus Swab Sampling for Evaluating Water Lines



Farm using gas chlorine- drip samples were acceptable but swab showed lines full of biofilm

Farm X:
Bacteria, Yeast and Mold Counts
Drip Collection vs Swab Collection



Monitoring Water System With Drip and Swabs Helps Identify Weaknesses

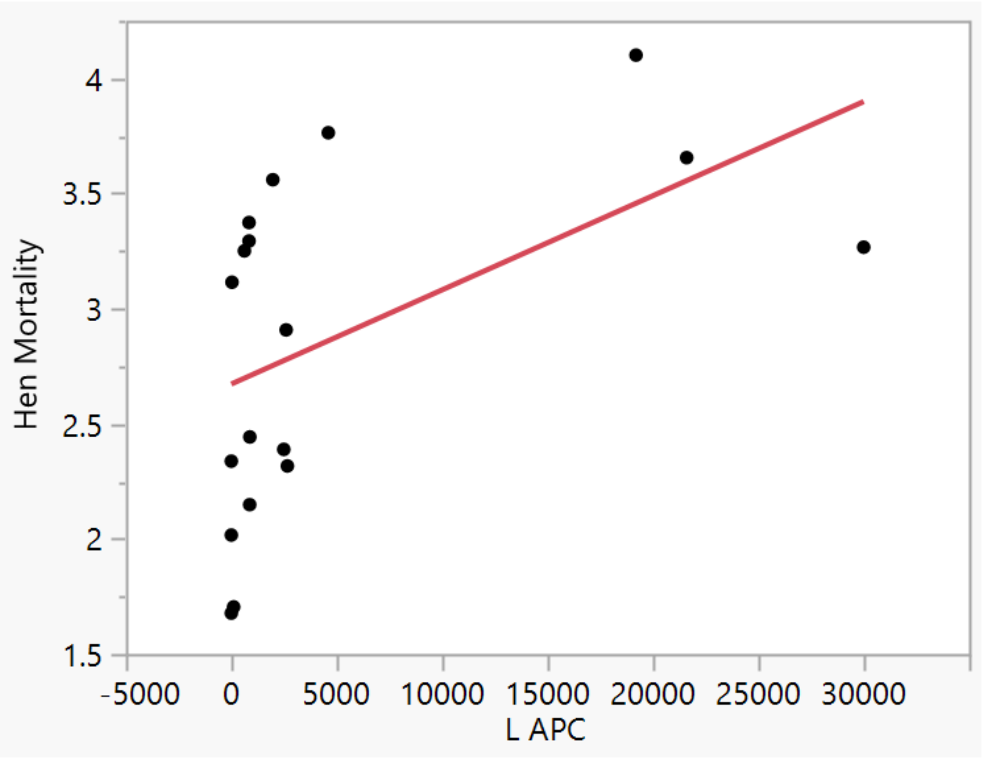
Source	Drip/Swab	APC (aerobic) (CFU/ml)	Yeast	Mold	E. Coli
House 1	Drip	20	0	0	0
House 1	Swab	154,000	0	11	0
House 2	Drip	1	0	0	0
House 2	Swab	9,100	0	7	0
House 3- Control Room	Drip	1	0	0	0
House 3- End of Line	Drip	72	3	1	0
House 3	Swab	291,000	310	290	0
House 4	Drip	1	0	0	0
House 4	Swab	1,130	675	65	0

Take action

- Use test results to assess strengths and weaknesses
  - Develop programs that compliment the water
  - Invest in water quality technology
  - If systems are dirty, implement a cleaning program when no flocks are present
- Use data to determine value of program

Drinking Water Bacteria and Hen Mortality

Total Aerobic Bacteria cfu/ml



Courtesy: Dr David McCreery, Pilgrim's Pride

Water Sanitation-Chlorine

- Still an effective sanitizer tool
- To optimize chlorine effectiveness:
  - pH range of 4.0 to 7.0
  - Clean water- no turbidity or “dirtiness”
  - Clean system-no biofilm slime
  - Adequate exposure time based on residual
  - Fresh chlorine product
  - Product properly stored and injected

Chlorine abuse and misuse results in challenges breaking through

How much chlorine is too much?

The better questions are:

How much product is added to the water to get the desired chlorine residual?

Is this residual adequate for controlling microbial growth?

- Chlorine is stabilized at pH 11, this requires
  - **sodium hypochlorite**
  - **calcium hypochlorite**

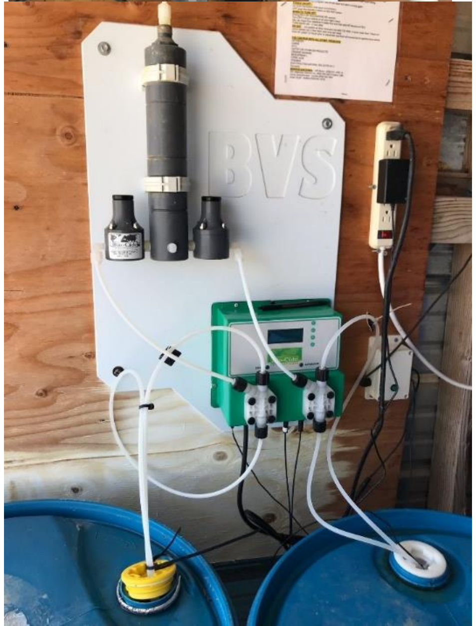
  Both of these taste bitter- the more added, the more bitter the water

- How much free Cl residual achieved without affecting water consumption will be dependent on:
  - What is product concentration?
    - 6 %   versus 12% ?
      - Stronger concentration requires less product to achieve sanitizer goal
  - How has the product been stored?
    - Sunlight causes significant loss of Chlorine
  - How long has the product been stored?
    - As product storage time increases, chlorine strength decreases
  - What is the storage temperature?
    - Warmer temperature increases Chlorine loss

Chlorine Dioxide

- Strong oxidizer
  - Better virucide than Cl
- Effective at higher pH
  - **More effective pH 8 versus 6**
- Target residual
  - Total ClO_2-up to 5 ppm
  - Free residual ClO_2- 1 ppm
  - Monitor free
- Available as:
  - Ready to use products-5-7% solutions of sodium chlorite
  - Dry acid/Na-chlorite added together in stock solutions
  - Liquid Sodium chlorite + acid = 60-80 % chlorine dioxide
    - Liquid inorganic acids best activator
    - Quality acid reduces risk of mineral contaminants

    Best when the activation chamber promotes mixing



Monitor and Document

Consistent monitoring assures sanitizer residual is present

Documentation essential for correlating performance with water sanitation

Sanitation Verification

Farm Name	Source	Drip/Swab	APC (aerobic) (CFU/ml)	Yeast	Mold	E. Coli	Coliforms
Farm A	Waterline	Swab	2	0	0	0	0
Farm A	Waterline	Swab	3	0	0	0	0

Farm Name	Source	Drip/Swab	APC (aerobic) (CFU/ml)	E. Coli	Coliforms
Farm B	Well	Drip	109	0	0
Farm B	End of line	Drip	0	0	0

Acidifiers are not Sanitizers

Table 1. Effect of Common Acidifiers on Aerobic Bacterial Counts from Dirty Water.

Product	pH	Aerobic Bacterial Counts (Log_{10})		
		Pre-Treatment Counts	Post-Treatment 2 Hours	Post-Treatment 24 Hours
Control (Dirty Water)	7.94	6.68	6.62c	6.47b
Acidified Copper Sulfate	4	6.71	4.22a	4.15a
Acidified Copper Sulfate	6	6.62	4.49a	4.42a
Citric Acid (Food Grade)	4	6.88	6.75c	6.35b
Citric Acid (Food Grade)	6	6.60	6.52c	6.38b
Citric Acid (Russell)	4	6.71	6.48c	6.27b
Citric Acid (Russell)	6	6.71	6.71c	6.57b
Sodium Bisulfate	4	6.74	5.87b	6.17b
Sodium Bisulfate	6	6.69	6.52c	6.44b
SEM		.14	.18	.15
P Value		.9470	.0001	.0001

a,b,c Means in a column with different letters were different ($P<0.05$).

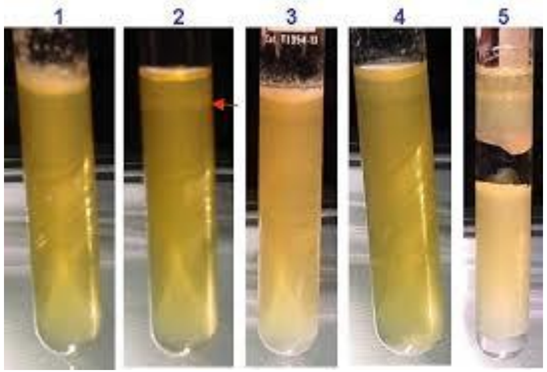
Slime challenges

- Increased organic acid use for gut health and food safety- resulting in water system slime issues
- Isolated following:
  - Pseudomonas aeruginosa
  - Brevundimonas vesicularis
- Conducted disinfectant sensitivity test

Disinfectant sensitivity

- 50 % stabilized H_2O_2
  - 2 ml/128 ml stock solution
  - Add 1:128
- 10% sodium hypochlorite
  - 4 ml/128 ml stock solution
  - Add 1:128
- 56% acetic acid
  - 1 ml/128 ml stock solution
  - Add 1:128
- Acetic acid/bleach
  - Combined at above rates
- Acetic acid/H_2O_2
  - Combined at above rates
- Control-no treatment

- 100 ul of each product/combo added to 3 BHI tubes per organism



Results-Organism response (24 hours)

Treatment	*P. aeruginosa*	B. vesicularis
Acetic acid	1 in 3 tubes (24 hours)	3 in 3 tubes (48 hours)
H2O2	3 in3 tubes	No growth
Bleach	No growth	No growth
Acetic acid/H_2O_2	No growth	No growth
Acetic acid/bleach	No growth	No growth

Control-3 of 3 growth for both organisms (24 hours)

Conclusion

- Organic acids without sanitation can lead to slime challenges/ clogged drinkers
- More evaluations needed to determine the conditions which promote this incidence but currently know that if water is susceptible to pseudomonas, there is a risk
- Sanitizer sensitivity is a tool to determine what is best for your operations
- If it happens-turn off acid-start chlorination using sodium hypochlorite for the birds
  - Raises pH and adds sanitizer

The Watkin’s Water Recipe

- Accept that water can create risks for flocks
- Identify and quantify water contaminants
  - Minerals, pH
  - Bacteria, yeast, mold, other
- Prepare a strategy to reduce/eliminate challenges
- Use between flock line cleaning to reduce challenges
- Utilize a daily water sanitizer best suited for the operation
  - Compatible with water
  - Easy to use
  - Easy to monitor
  - Cost effective-in the scheme of things
- Monitor and verify program works
- If you believe in a water program, the team will too

https://pippoultrywaterapp.com/

University of Alberta Water app