

TREATING WATER FOR THE FOOD INDUSTRY



Regulatory Authority

- USDA
 - Meat
 - Poultry
 - Frozen, dried and liquid egg



If an establishment uses a municipal water supply, it must make available to FSIS, upon request, a water report, issued under the authority of the State or local health agency, certifying or attesting to the potability of the water supply. If an establishment uses a private well for its water supply, it must make available to FSIS, upon request, documentation certifying the potability of the water supply, that has been renewed at least semi-annually.



FSIS: Food Safety Inspection Service

Regulatory Authority

Food and Drug Administration

- FDA is responsible for the safety of 80% of all food consumed in the United States
 - Entire domestic and imported food supply
 - Except Meat, Poultry & Frozen, dried and liquid egg (USDA)
 - 21 CFR § 165.110 - Bottled water.

Foods Under FDA Authority

- Dairy Products – Milk, Cheese, Butter
- Plant Products – Vegetables, Fruits, Nuts
- Juices
- Spices
- Seafood – Finfish, Shellfish, Crustaceans, Surimi based
- Grain-based – Bread, Cereals, Flour
- Bottled Water
- Infant Formula
 - Dietary supplements
 - Cosmetics
 - Drugs

It May Be Tap Water

Some bottled water also comes from municipal sources—in other words, the tap. Municipal water is usually treated before it is bottled. Examples of water treatments include

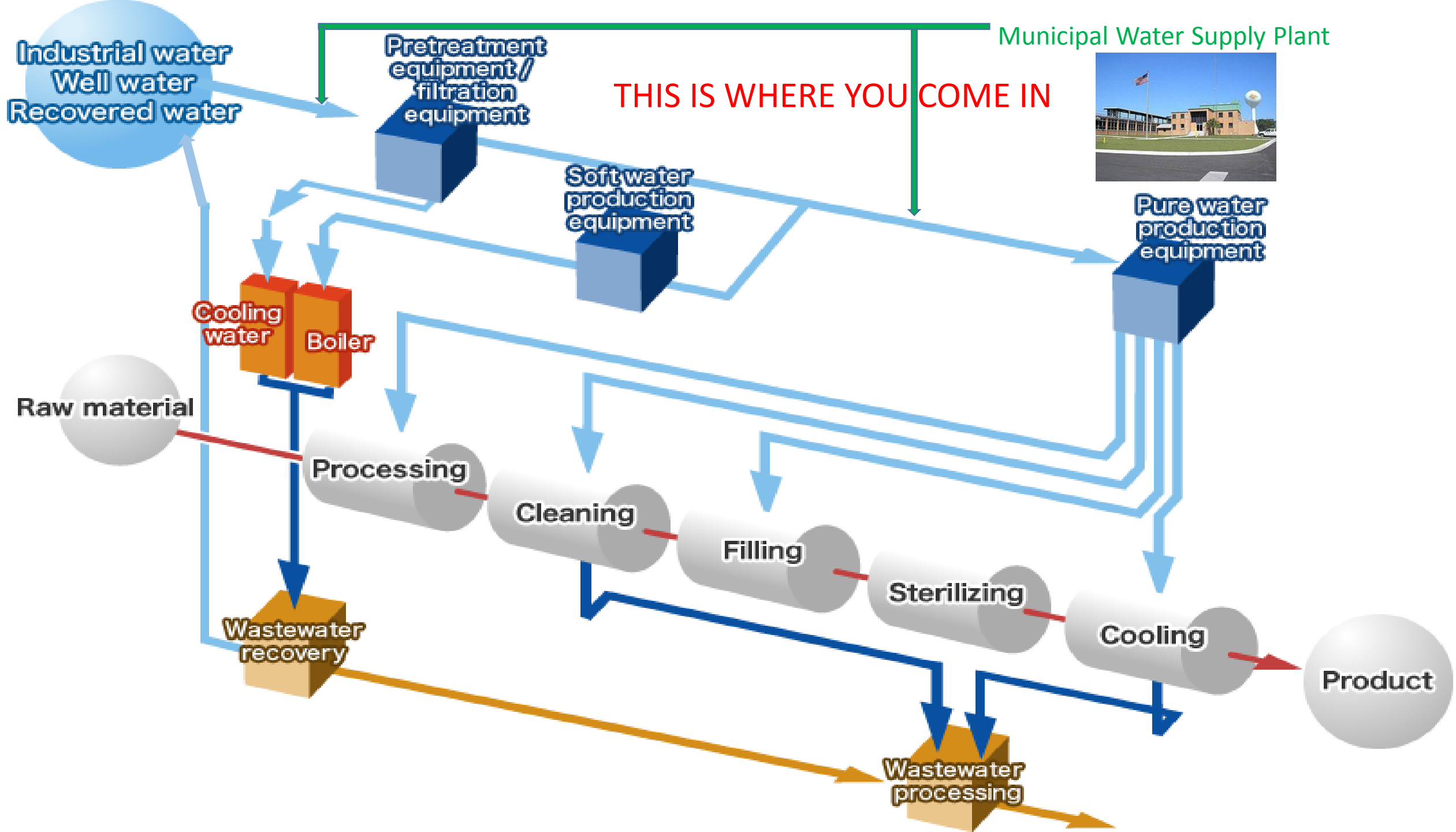
Distillation. Water is turned into a vapor, leaving minerals behind. Vapors are then condensed into water again.

Reverse osmosis. Water is forced through membranes to remove minerals.

Absolute 1 micron filtration. Water flows through filters that remove particles larger than one micron—.00004 inches—in size. These particles include *Cryptosporidium*, a parasitic pathogen that can cause gastrointestinal illness.

Ozonation. Bottlers of all types of waters typically use ozone gas, an antimicrobial agent, instead of chlorine to disinfect the water. (Chlorine can add residual taste and odor to the water.)

Bottled water that has been treated by distillation, reverse osmosis, or another suitable process may meet standards that allow it to be labeled as “purified water.”



MAUMEE RIVER BASIN

- At 8,316 square miles, the Maumee is the largest river basin in all the Great Lakes.



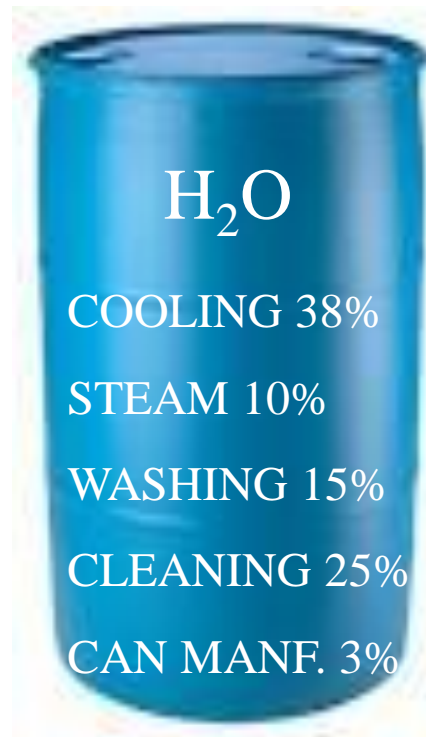
62 acres under roof



MAUMEE RIVER



It Takes 42 Gallons to make one case of soup



COOLING COMPRESSORS 7%

WATER IN CANS & BOTTLES 2%

?



The Water You Make is being used this way!

WATER

Treatment

Plant

15.0 MGD

LIME SODA SOFTENING



MAUMEE RIVER AVERAGE CONSTITUENTS

- TOTAL HARDNESS (CaCO_3) 271 mg/L
 - TOTAL ALKALINITY 157 mg/L
- CALCIUM HARDNESS (CaCO_3) 168 mg/L
- MAGNESIUM HARDNESS (CaCO_3) 103 mg/L
 - CARBONATE HARDNESS 157 mg/L
- NONCARBONATE HARDNESS 114 mg/L
 - TURBIDITY 178 NTU'S
 - NITRATES 4.1 mg/L
 - SULFATE 90.43 mg/L



Low Service Pumping Station

The image shows two large, white, cylindrical rotating screen machines in a wastewater treatment plant. The machine on the right has a label that reads "Rex" and "Envirex" with "rotating water screen" below it. The number "2" is visible on its side. The machines are situated in a room with concrete block walls and large windows with corrugated metal panes. A metal railing is visible in the background. The floor is concrete with a metal grate in the foreground.

Rotating Screen

**CHEMICALS
AVAILABLE**

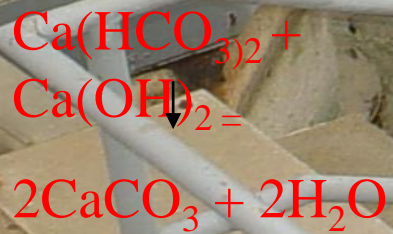
preoxidation

- CHLORINE
DIOXIDE
- KMnO_4
- POWERED
ACTIVATED
CARBON

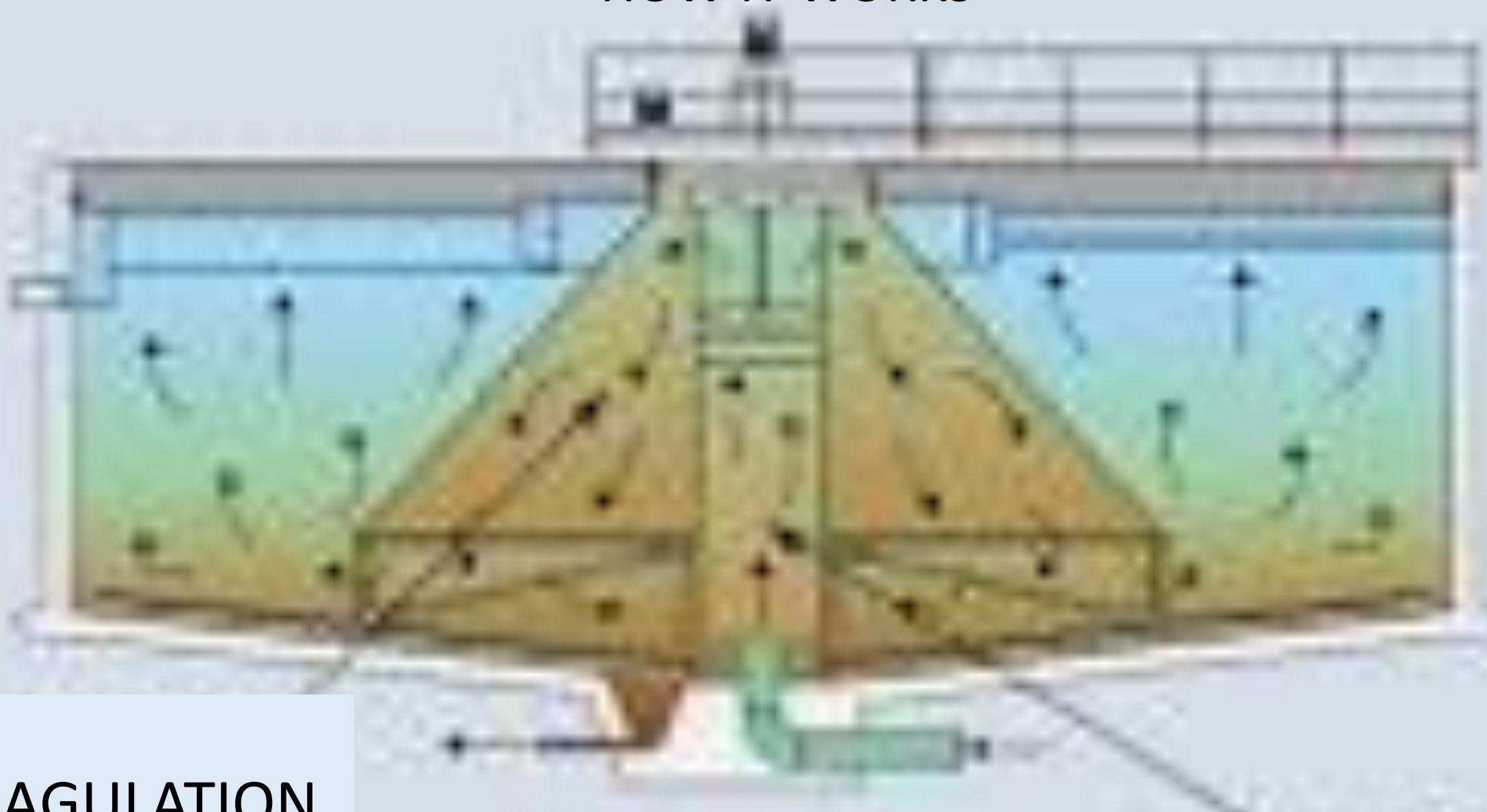
UPFLOW CLARIFIER

FERRIC SULFATE

Lime 10.4 to 10.8



HOW IT WORKS



COAGULATION
ZONE

MIXING ZONE

LIQUID CO₂

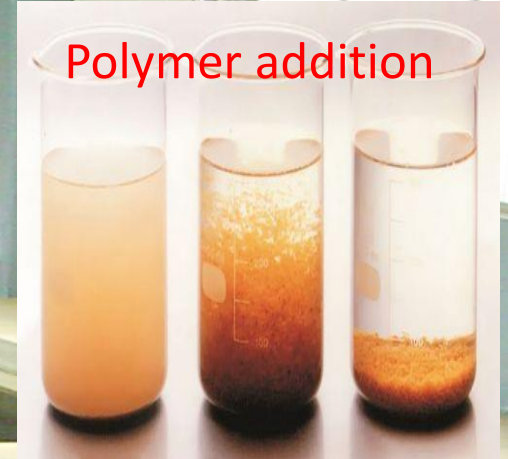




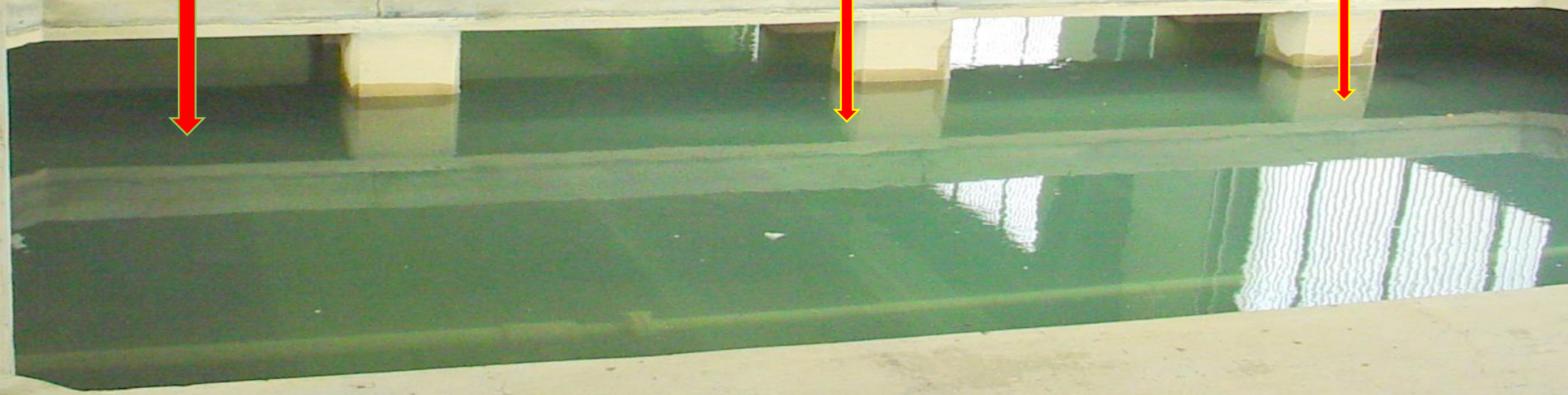
PAC



SHMP Powder



Polymer addition



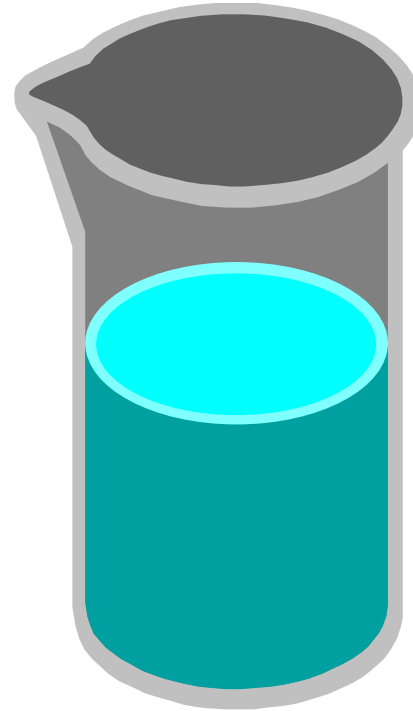
CONVENTIONAL SAND FILTER

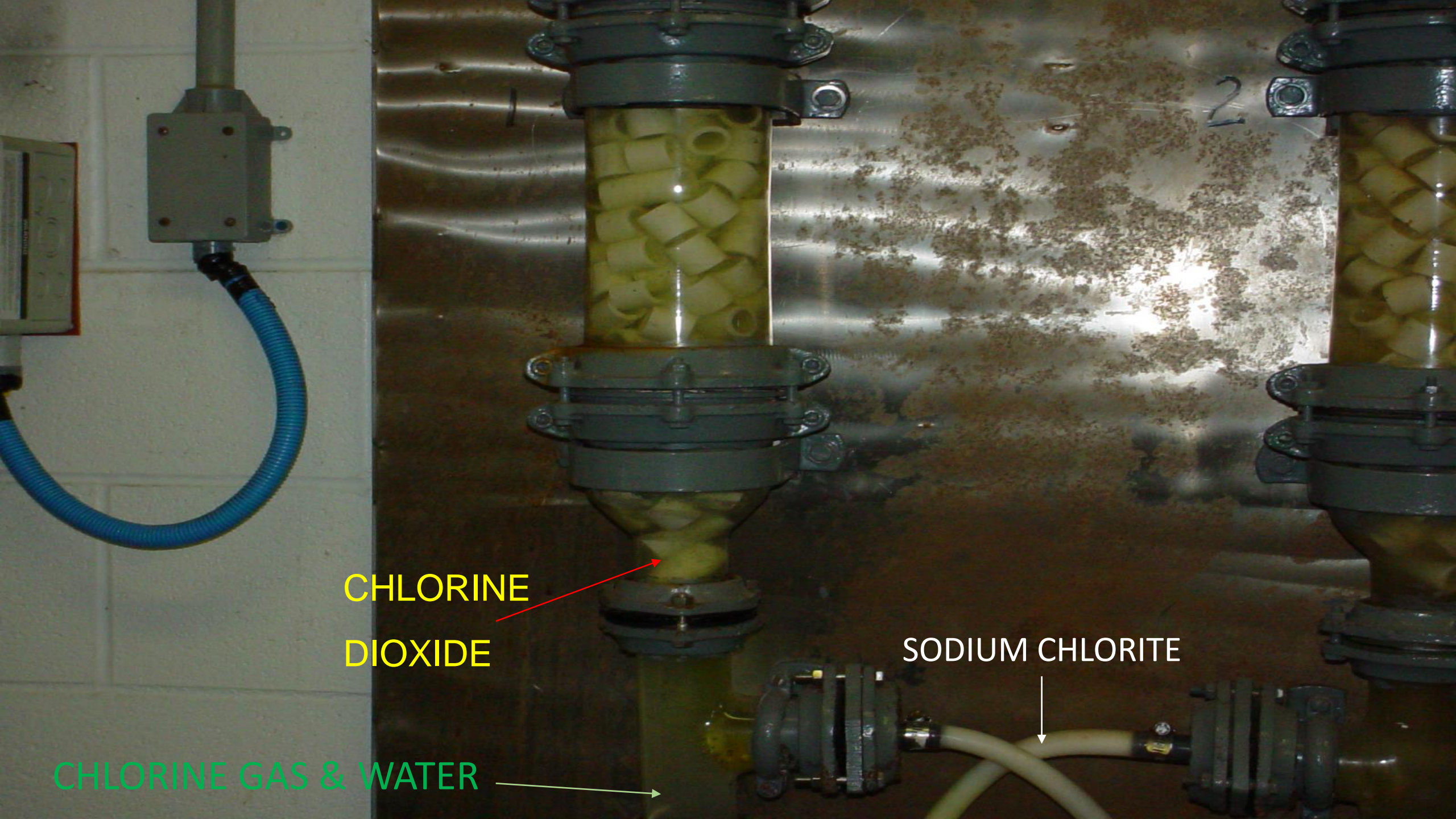
MULTI MEDIA FILTER



Chlorine Chemistry

- Chlorine gas hydrolyzes in water to form hypochlorous acid (HOCl):
$$\text{Cl}_2 + \text{H}_2\text{O} \rightarrow \text{HOCl} + \text{H}^+ + \text{Cl}^-$$
- H^+ ions released in the reaction cause a reduction in pH. (sample is more acidic)

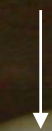




CHLORINE
DIOXIDE



SODIUM CHLORITE



CHLORINE GAS & WATER



FINISHED WATER

- Total Hardness 129 mg/L
- Calcium Hardness 88 mg/L
- Total Alkalinity 51 mg/L
- pH 8.8
- Langelier Index +0.67
- Chlorine Residual 2.2 mg/L
- Total Dissolved Solids <250 mg/L

Total Hardness needed to be <140 mg/L or the outside of the bean would harden and the inside would turn to mush and watery after blanching.



BAKERY GOODS

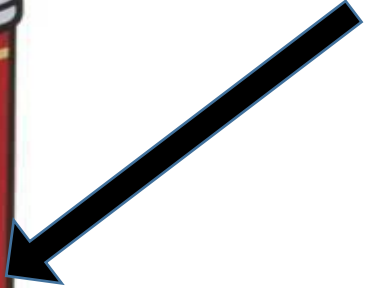
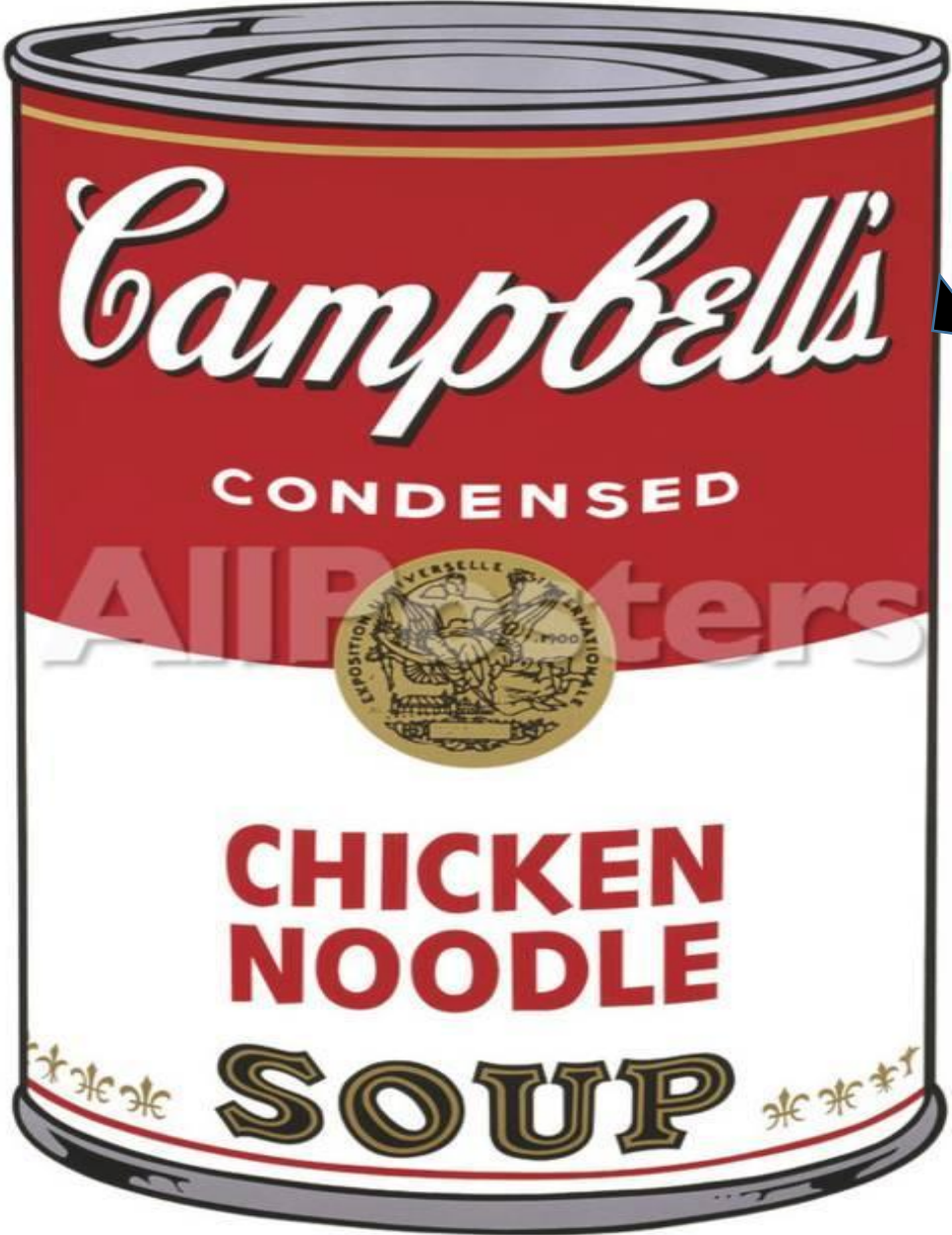
examples of how water hardness may affect the quality of baked goods. Calcium and magnesium precipitate from hard waters in steam lines and can then be carried by the steam used in bakery ovens to create spots on the top crust of breads and rolls.



OBSTACLES OVER THE YEARS

- PHENOLIC RESINS FROM John's Manville - Defiance, Ohio
- Woodburn Indiana Seed Firm Blaze
- Nitrates from Farm Runoff
- Rusty Cans
- OUTSOURCING INTERNAL PLANT FUNCTIONS
- Taste and Odor Problems Due to Algae
- Concerns with developing microcystin levels
- The Invaders
- Capacity with Increased Production

PHENOLIC RESINS



SHREDDER

Magnet separates steel and
throws into hopper

STEEL & VEGETABLES MIXED

Discarded
Vegetables

30

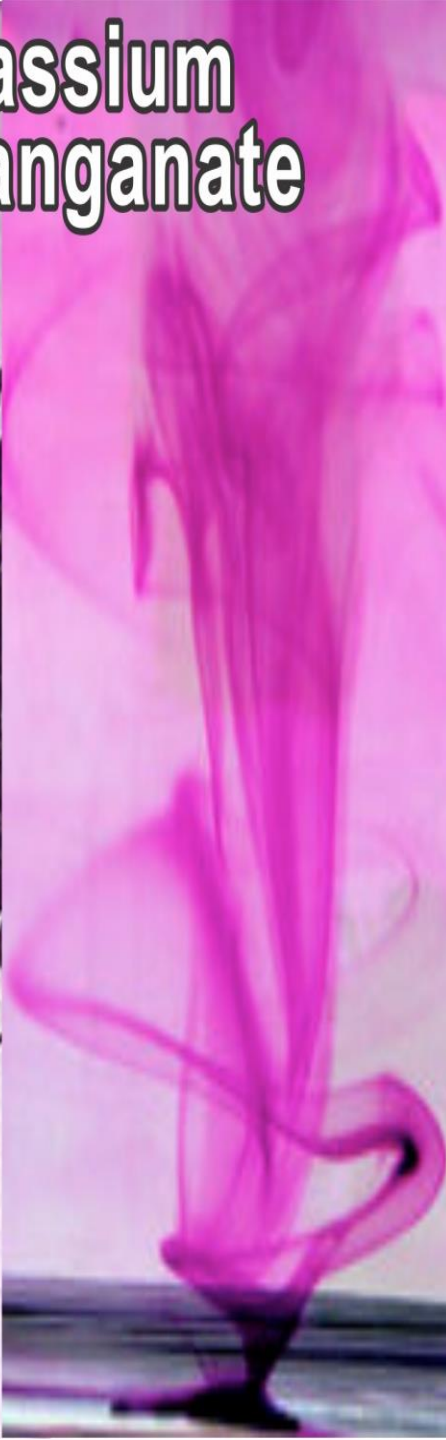
STEEL





$KMnO_4$

Potassium
Permanganate



Chlorine Dioxide

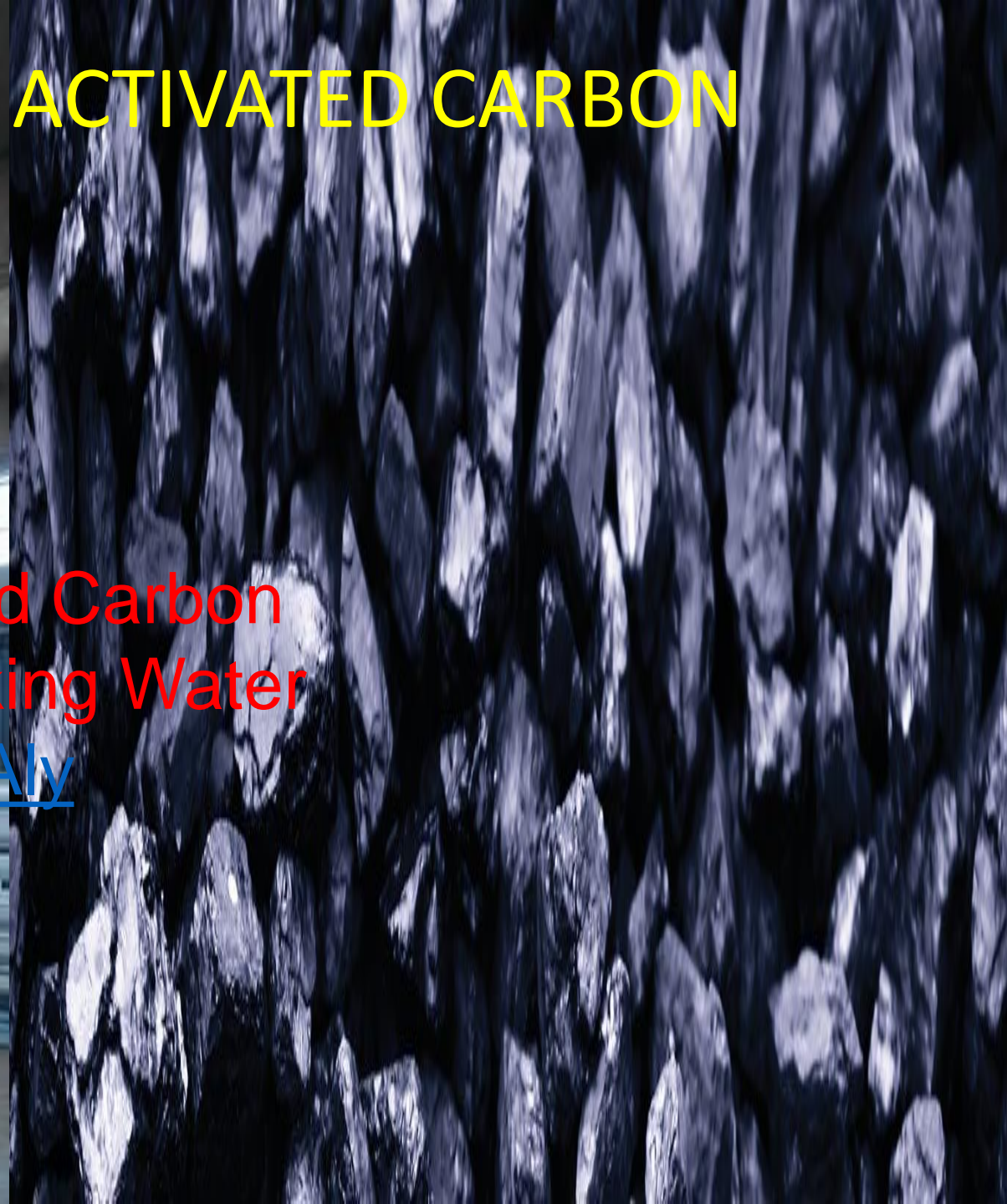


GRANULAR

ACTIVATED CARBON

Biological Activated Carbon
Treatment of Drinking Water
Author [Osman M.Aly](#)

Activated Carbon Filters



Taste buds and taste receptors

Humans have taste receptor cells (TRCs) that can

differentiate between five major “taste qualities”:

- bitter
 - sweet
 - sour
 - salty
 - umami
- What is umami and what does it taste like?**
Umami describes food that are savory, earthy, and meaty. You can taste it in foods like meat broths, some cheeses, miso, seaweed, and mushrooms. Umami’s taste is relatively mild, but it does have an aftertaste. For some people, it can cause salivation and a sensation of furriness on the tongue.

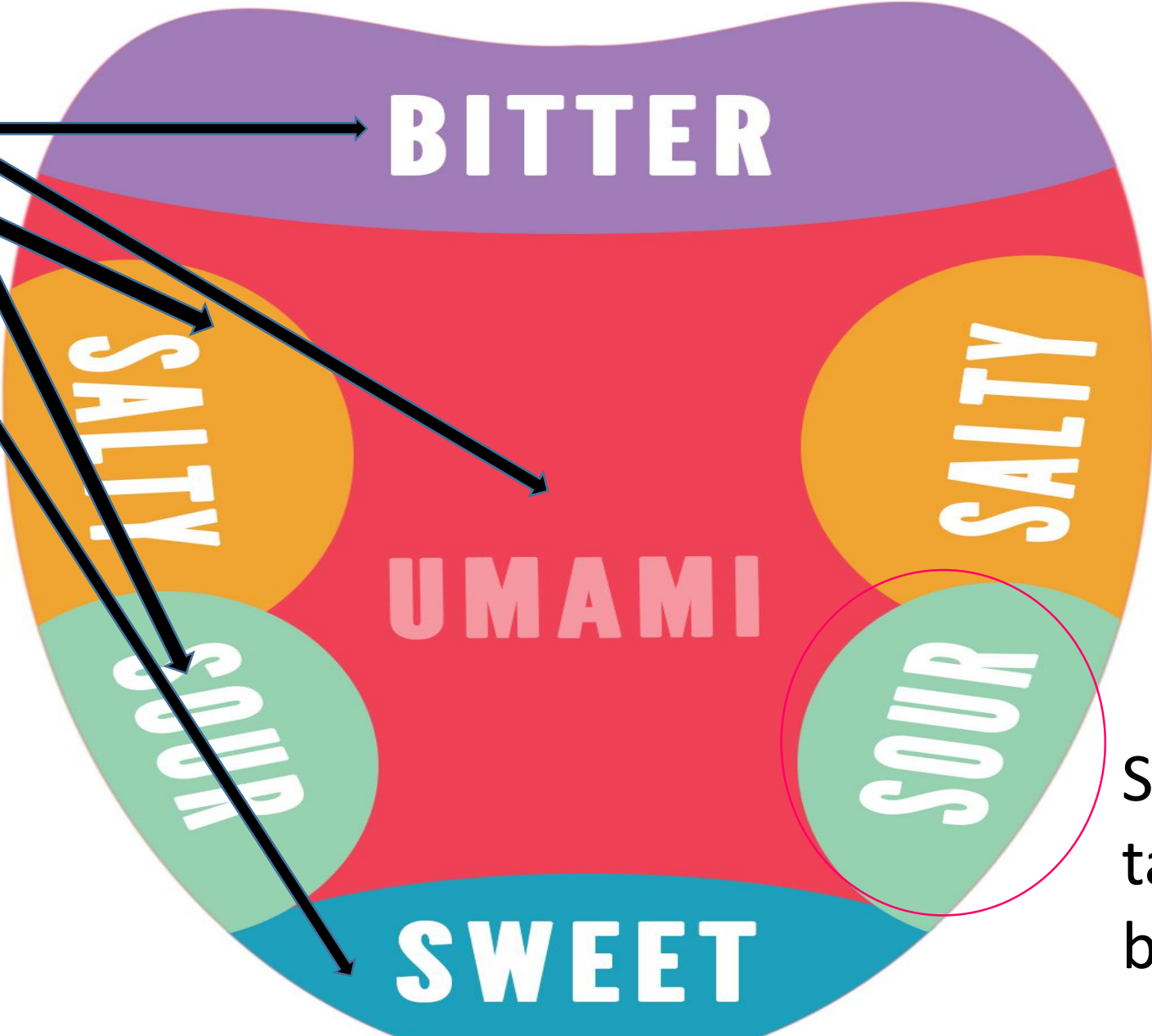
Each of these qualities causes TRCs to activate a different

part of your brain, and water has been found to activate

the “sour” TRCs.

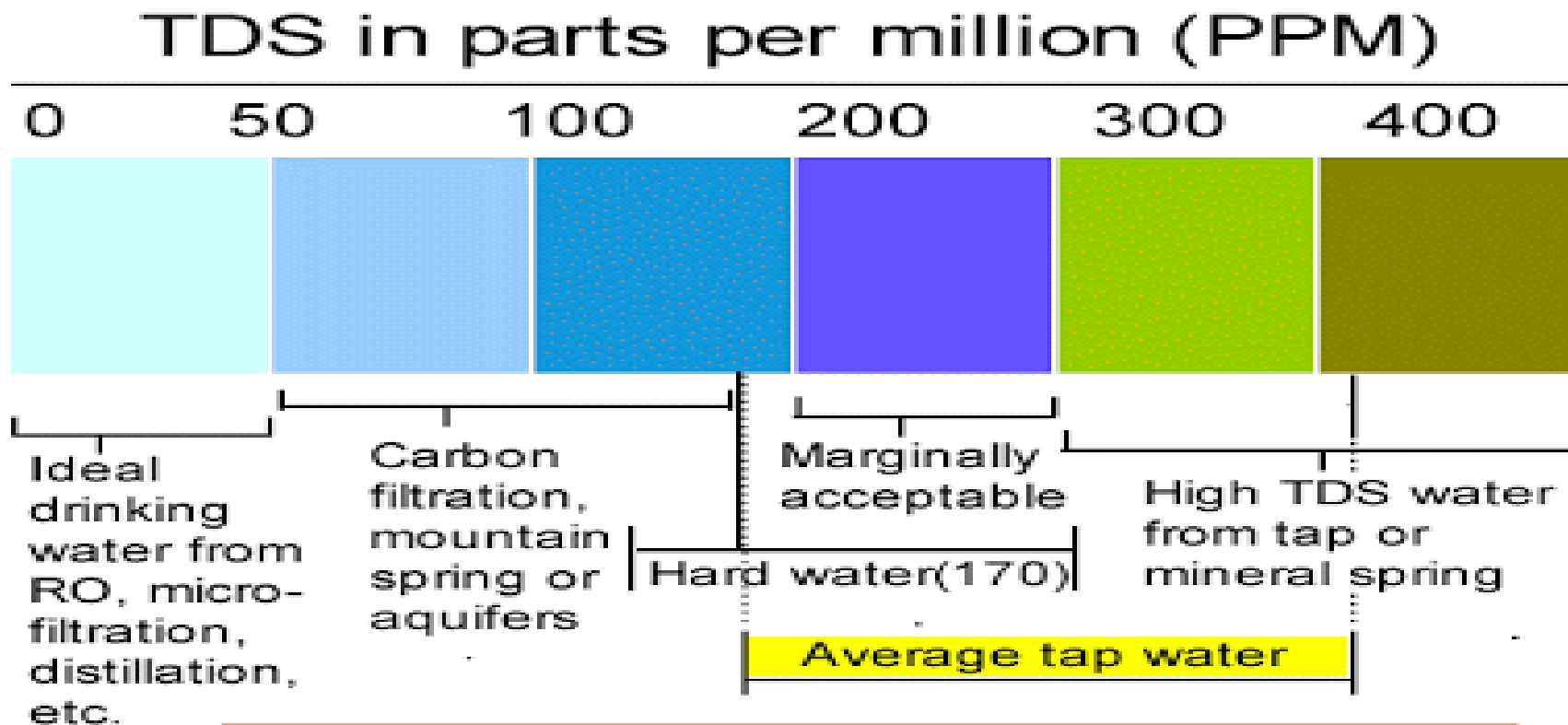
HUMAN TONGUE

5 MAJOR
TASTE
QUALITIES
And where
they are
located on
the tongue



Send water
taste to the
brain

The palatability of drinking- water has been rated by panels of tasters in relation to its TDS level as follows: **excellent, less than 300 mg/liter**; **good, between 300 and 600 mg/liter**; **fair, between 600 and 900 mg/liter**; **poor, between 900 and 1200 mg/liter**; and **unacceptable, greater than 1200 mg/liter.**



US EPA's maximum contamination level is 500+

Chart values represent national U.S. averages. Actual TDS levels for geographic regions within the US and other countries may vary

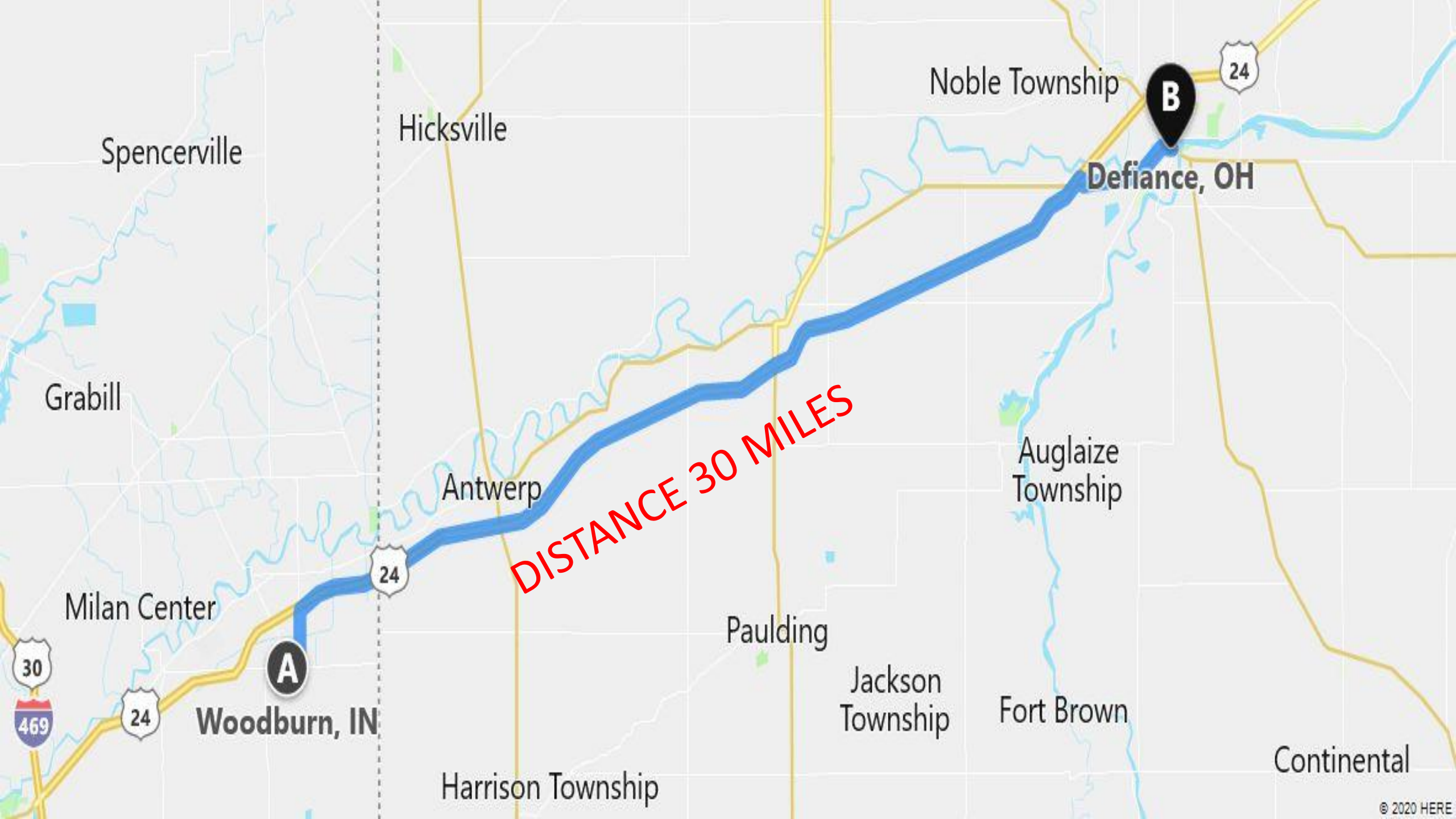
SEED Firm Blaze forced 5,000 to Flee is Doused May, 1987

WOODBURN, Ind. — Firefighters extinguished a smoldering fire Saturday at a seed company plant that had forced the evacuation of more than 5,000 people and contaminated a nearby river with farm chemical runoff, authorities said.

City of Defiance, Ohio mayor shuts down Defiance Water Treatment Plant in fear of contaminated river water.

MAJOR MISTAKE

*Measure the speed of the River before shutting
down*



Spencerville

Hicksville

Noble Township

B

24

Defiance, OH

Grabill

Antwerp

DISTANCE 30 MILES

Auglaize Township

Milan Center

24

A

Woodburn, IN

Paulding

Jackson Township

Fort Brown

Harrison Township

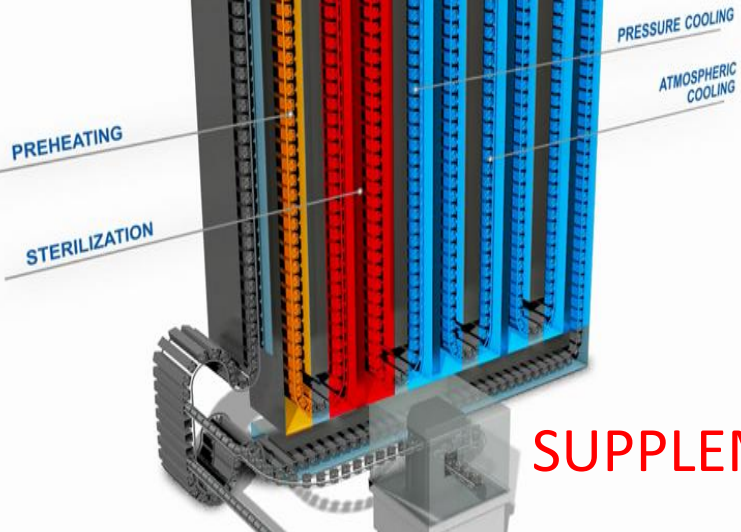
Continental

30

469

24

38%



SUPPLEMENTAL Chlorine Added

RUSTY CANS

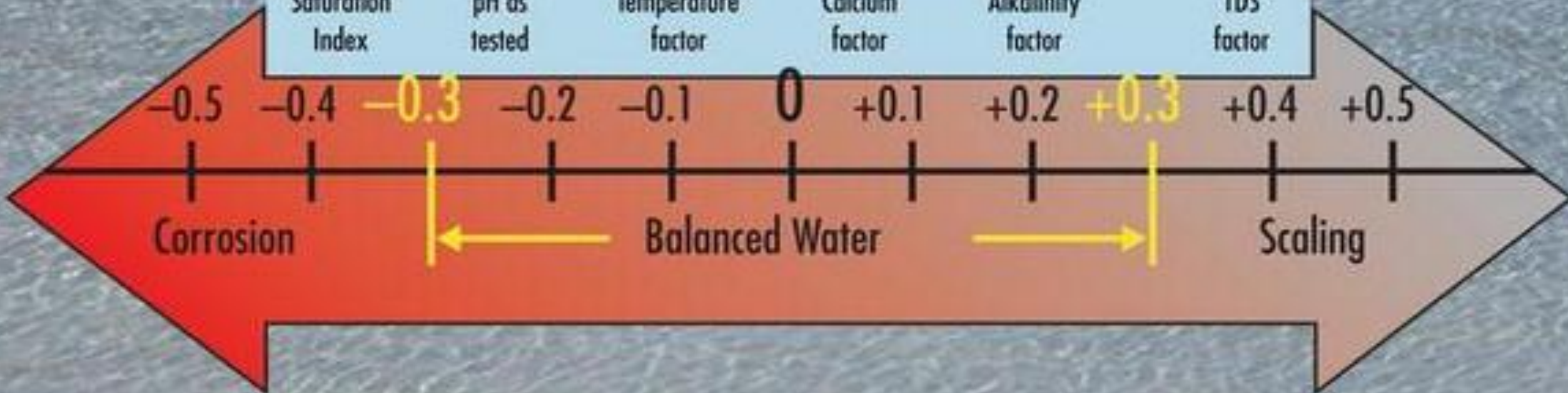
Rusty Cans or Too Much Scale formation ??



Langelier Saturation Index

$$SI = \text{pH} + Tf + Cf + Af - \text{TDSf}$$

Saturation Index	pH as tested	Temperature factor	Calcium factor	Alkalinity factor	TDS factor
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The *ideal* range for balanced water is between -0.3 to +0.3

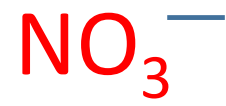
OUTSOURCING



All food processors should test water in the plant from different outlets at least once each year—and preferably more often. Operators should collect water samples from the farthest faucet from the line in the facility and preferably from the cold side. This should be done even if water is obtained from a city water system.



TIN CAN



Negatively Charged
Analyte [Anion]

Attracted to
Positive Surface



Positively Charged
Analyte [Cation]

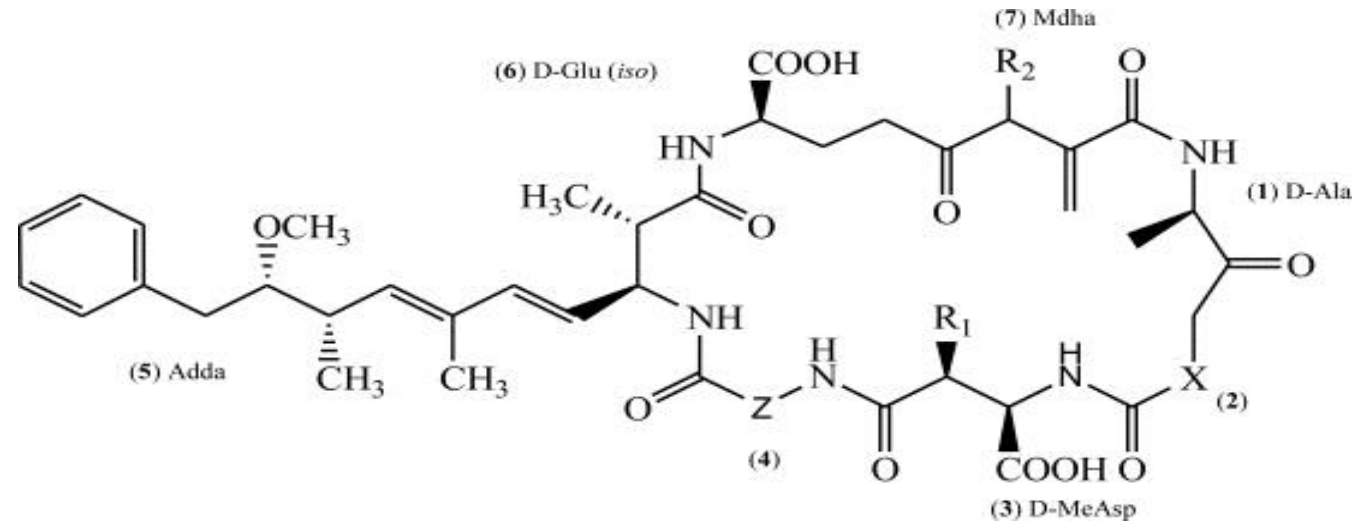
Attracted to
Negative Surface



DON'T DRINK THE WATER IN LAKE ERIE



Beware of ME !



My Name is **MICROCYSTIN** Microcystins (MC) are potent hepatotoxins produced by the cyanobacteria of the genera *Planktothrix*, *Microcystis*, *Aphanizomenon*, *Nostoc* and *Anabaena*. These cyclic heptapeptides have strong affinity to serine/threonine protein phosphatases (PPs) thereby acting as an inhibitor of this group of enzyme.



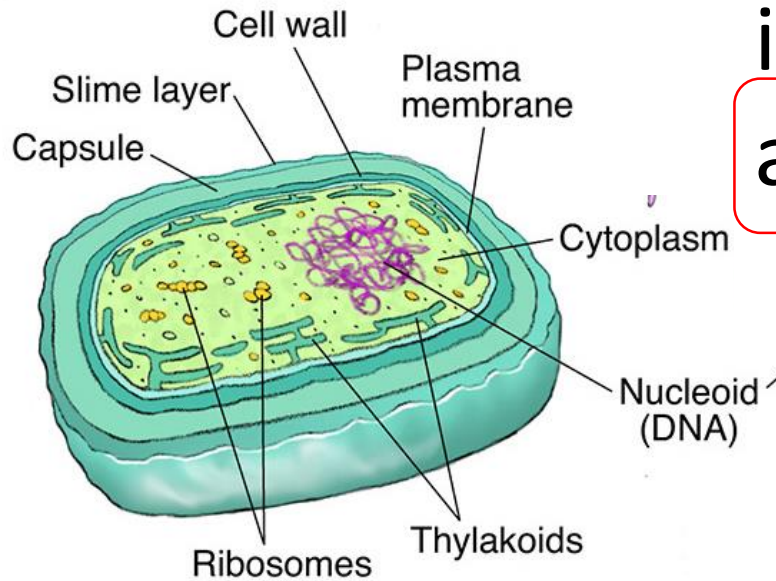
CONTROL

M. aeruginosa.



ENLARGED LIVER DUE TO
MICROCYSTIN

In most cases, the cyano
toxins naturally exist
intracellularly (in the cytoplasm)
and are retained within the cell.



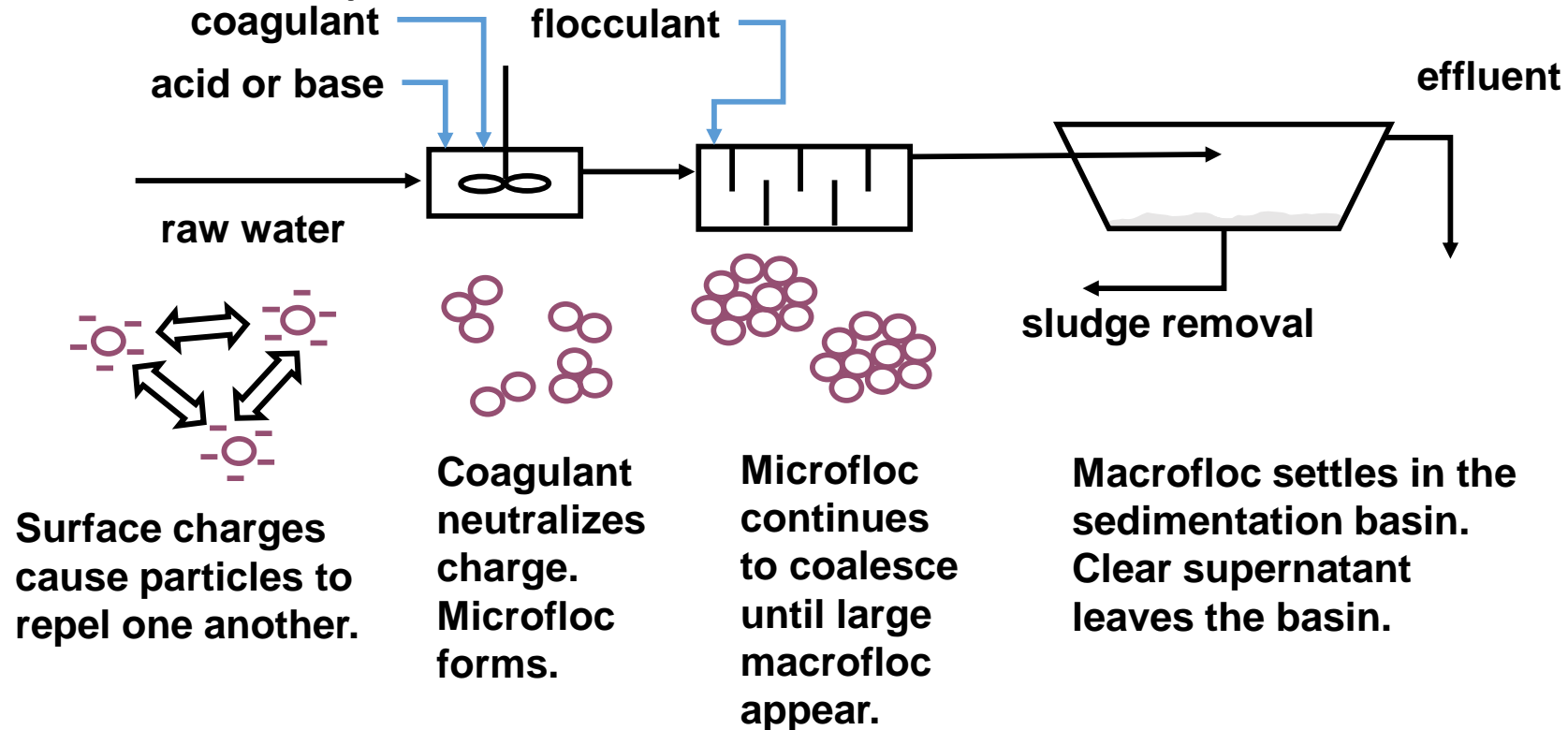
A. Photosynthetic bacterium (cyanobacteria)

Conventional treatment using coagulation will remove cyanobacteria cells; however, sludge containing toxic cyanobacteria should be isolated from the treatment process as cells contained in sludge can break down rapidly and release dissolved toxin.



Let's REVIEW: Coagulation, flocculation, and settling

- Removes suspended solids from raw water.



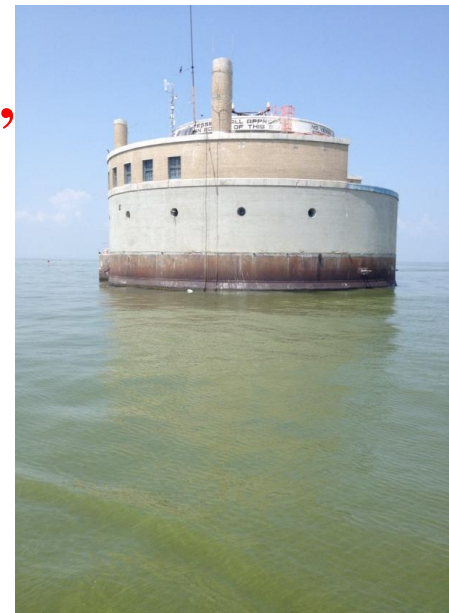
Floc Formation



The goal of flocculation is to promote growth of flocs to a size that can be removed by sedimentation and filtration.

A very effective way to deal with high microcystin concentrations therefore is to remove the cells, **intact** and without damage (Drikas et al. 2001; Hart et al. 1998). Any damage, such as that caused by preoxidation, may lead to cell leakage, and consequently in an increase of the dissolved toxin concentration on entering the treatment plant. **This may be critical, as dissolved toxin is not removed by conventional treatment technologies.**

TOLEDO'S
INTAKE



Chlorination and ozonation are effective for the removal of microcystins. A residual of at least 0.3 mg/ L of ozone for 5 minutes will be sufficient for all of the most common microcystins

For chlorine a dose of 3 mg/ L applied to obtain a residual of 0.5 mg/L for at least 30 minutes will be effective.

The image shows three petri dishes containing different forms of activated carbon. The first dish on the left contains a fine black powder. The middle dish contains dark, irregular granules. The third dish on the right contains dark, cylindrical pellets. The background is a blurred industrial facility at night.

Activated Carbons

Powder

Granular

Pellets

- Granular activated carbon filtration displays a limited lifetime for all toxins. This can vary between 2 months to more than one year depending on the type of toxin and water quality.

NOTE:

- Natural Organic Matter (NOM) breakthrough occurred prior to the MC-LR breakthrough and NOM preloading appears to affect the rate of MC-LR breakthrough. To determine your spent granular carbon capacity, doing Total Organic Carbon (TOC) testing will give you a better response time for granular carbon replacement and MC-LR breakthrough.

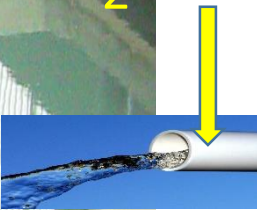
Removal of extracellular (free) cyanotoxins

Powdered activated carbon and granular activated carbon are very effective, depending on the carbon dose, the type of carbon (*wood-based powdered activated carbon for microcystin and cylindrospermopsin*) and *contact time (> 30 minutes recommended)*;

Coupling preoxidation with activated carbon is an effective way to remove both cyanotoxins and their potential transformation products. Moreover, the carbon must be regenerated or replaced at routine intervals, often based on the breakthrough of total organic carbon; however, toxin breakthrough may occur before significant total organic carbon breakthrough is detected.



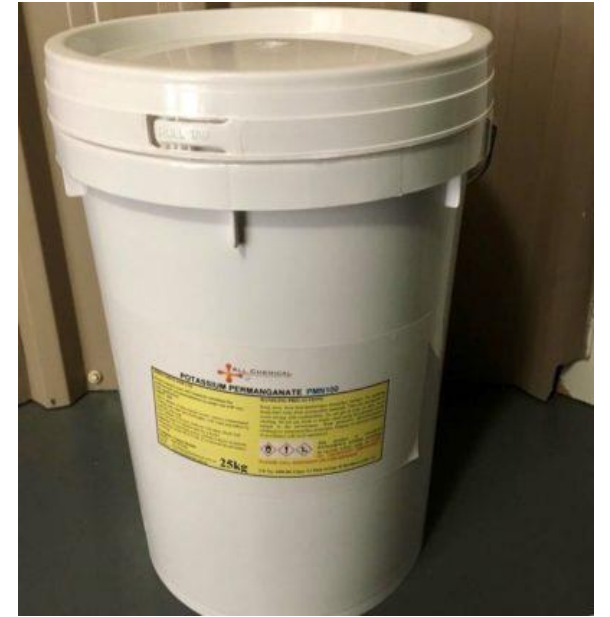
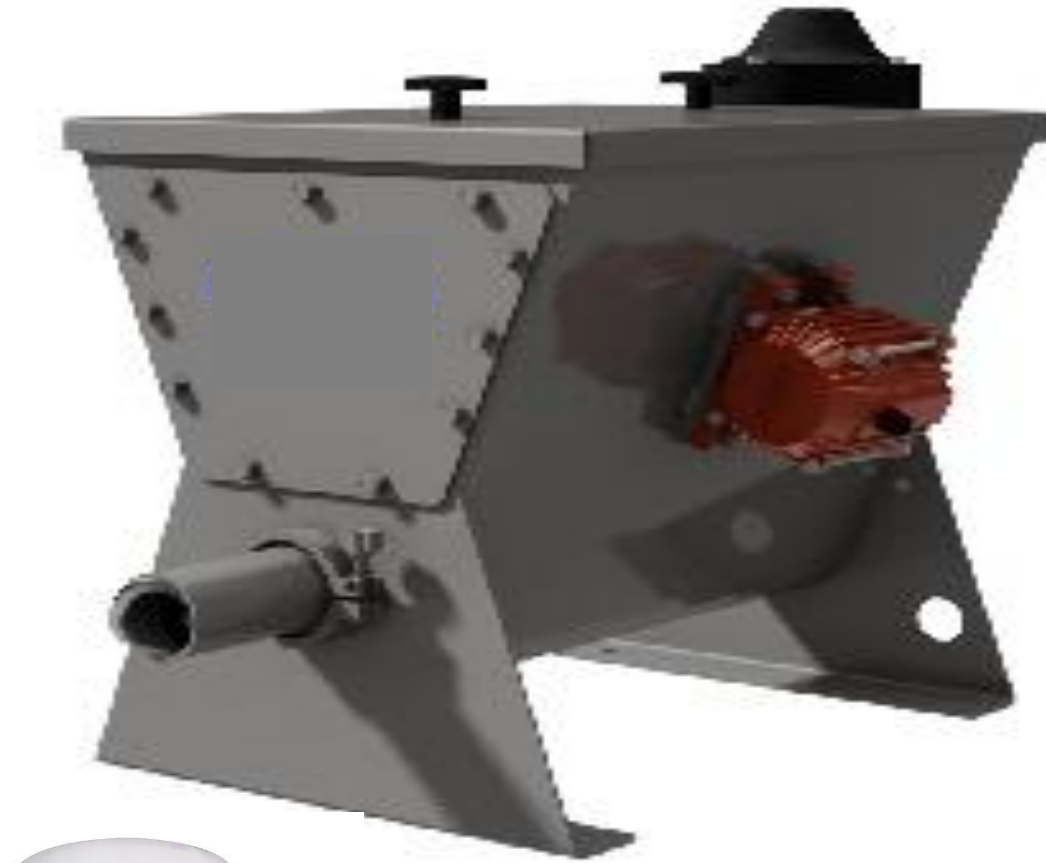
ADD PAC & Polymer after CO₂



CO₂

High pH due to excess Lime

POTASSIUM PERMANGANATE $KMnO_4$



A permanganate dose of 1-1.25mg/L was enough to reduce microcystins concentration below the guideline value of 1ppb. Permanganate oxidation is therefore a feasible option for microcystin removal during preoxidation processes. However, the oxidant dose must be carefully optimized in order to remove extracellular microcystins without causing cell lysis (due to chemical stress) and further release of MCs.



Designate a spokesperson (and alternate) and contact your local OEPA agency for delivering messages to the news media and the public.



- Have a script to refer to.
- Keep your answers positive to the media, while your talking into the microphone to the audience, reporters are thinking of the next question.
- Do not make statements, such as, the EPA allows a certain amount of contaminants in the water supply. Reporters will ask you to explain.
- Have an outline prepared as to what measures you are taking to resolve the issue.
- Use statements, such as, “thank you for asking that question” before leading into your answer. (It takes away the combativeness).

Zebra Mussels Threaten Inland Waters

Zebra mussels cost the U.S. economy at least \$1 billion annually. They clog water intakes for municipalities and industries.



Gizzard Shad

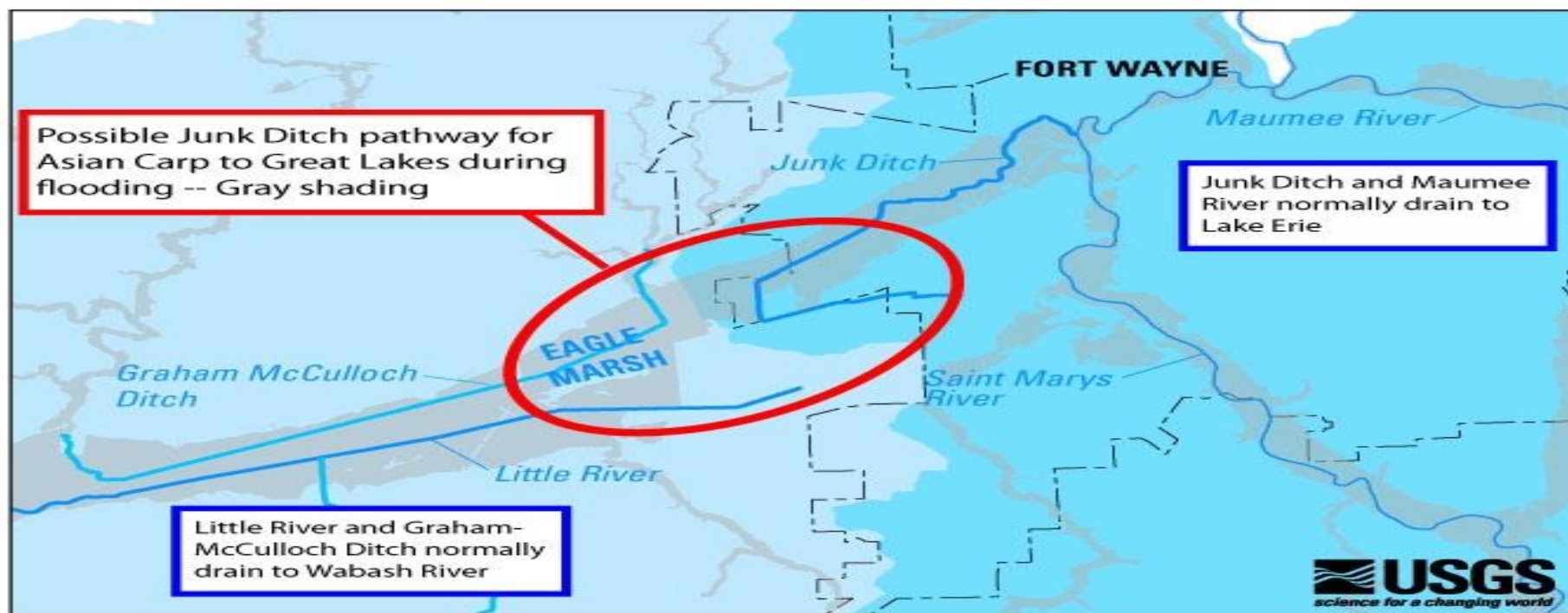


Allergic reaction to fish



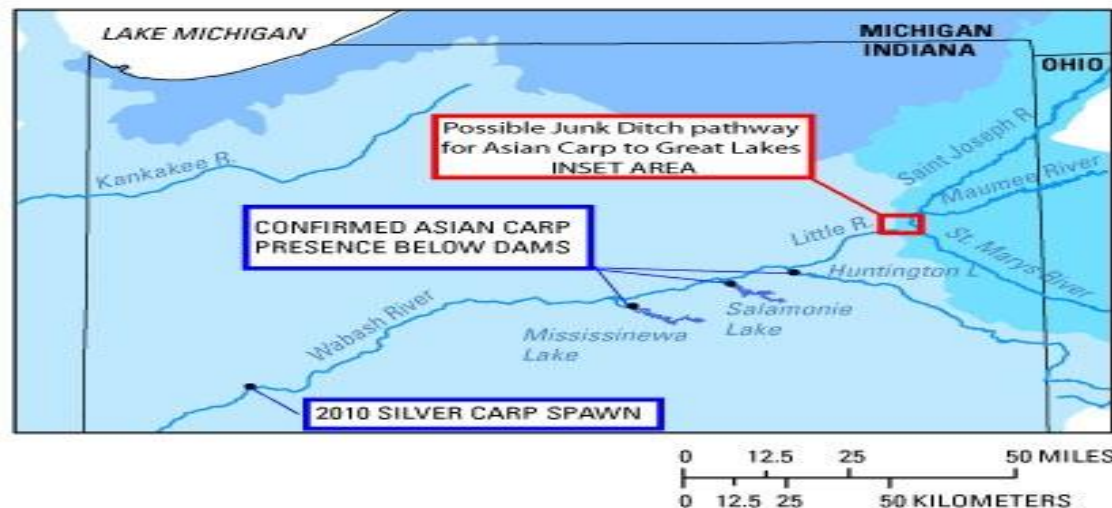
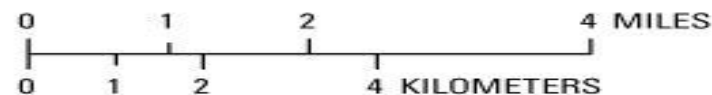
Asian Carp





EXPLANATION

- FLOOD PLAIN -- approximate
- DRAINS TO LAKE ERIE
- DRAINS TO LAKE MICHIGAN
- DRAINS TO MISSISSIPPI RIVER







USGS



SANITIZING H₂O LINES

62 ACRES UNDER ROOF

160° F

H₂O Plant

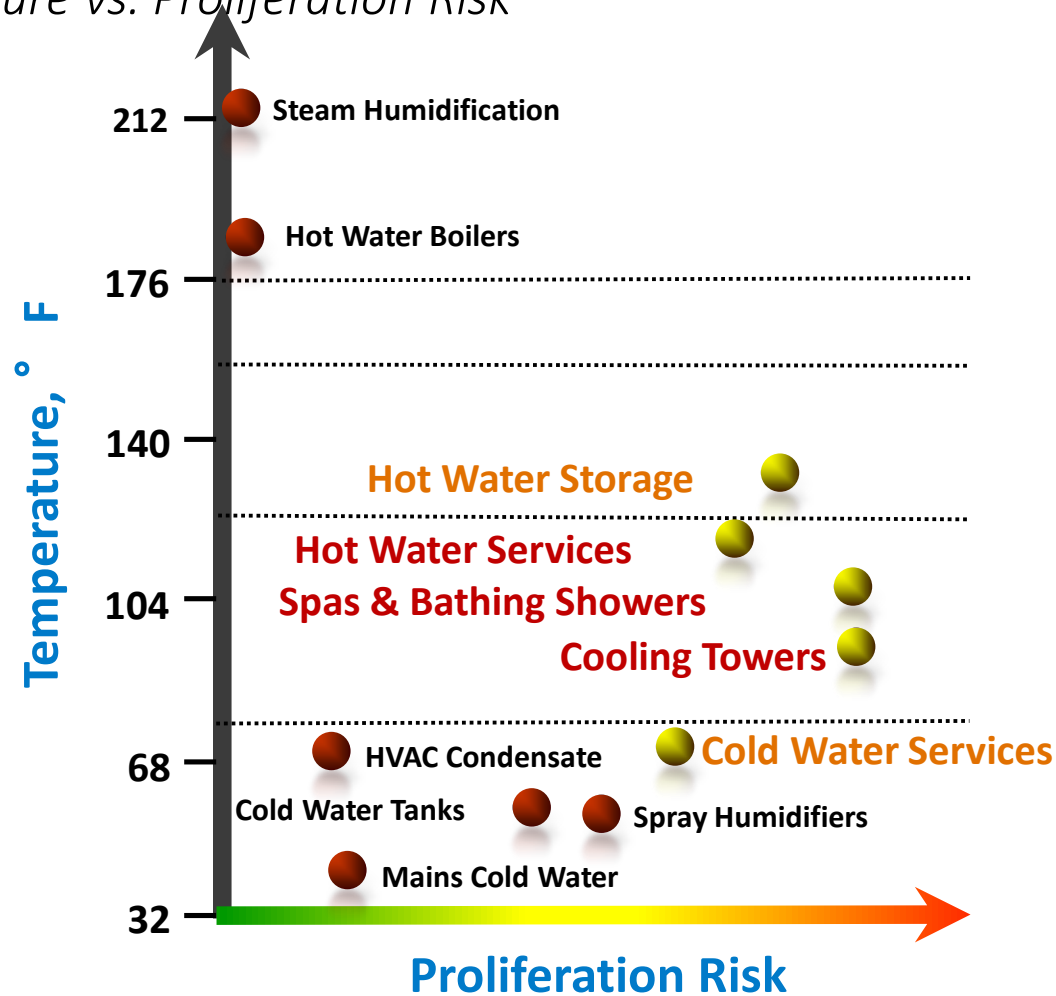
160° F

MAUMEE RIVER



Utility & Domestic Services

Temperature vs. Proliferation Risk



Disinfection Range
158 - 176°F

Slowly Die
122-158°F

- 131°F ; die within 5-6 hrs
- 140°F ; die within 32 min.
- 151°F ; die within 2 min.

Growth Range
77 - 122°F
95 - 115°F optimum

Do Not Grow Well
68-77°F
Below 68°F Dormant

HOW TO PROCEED

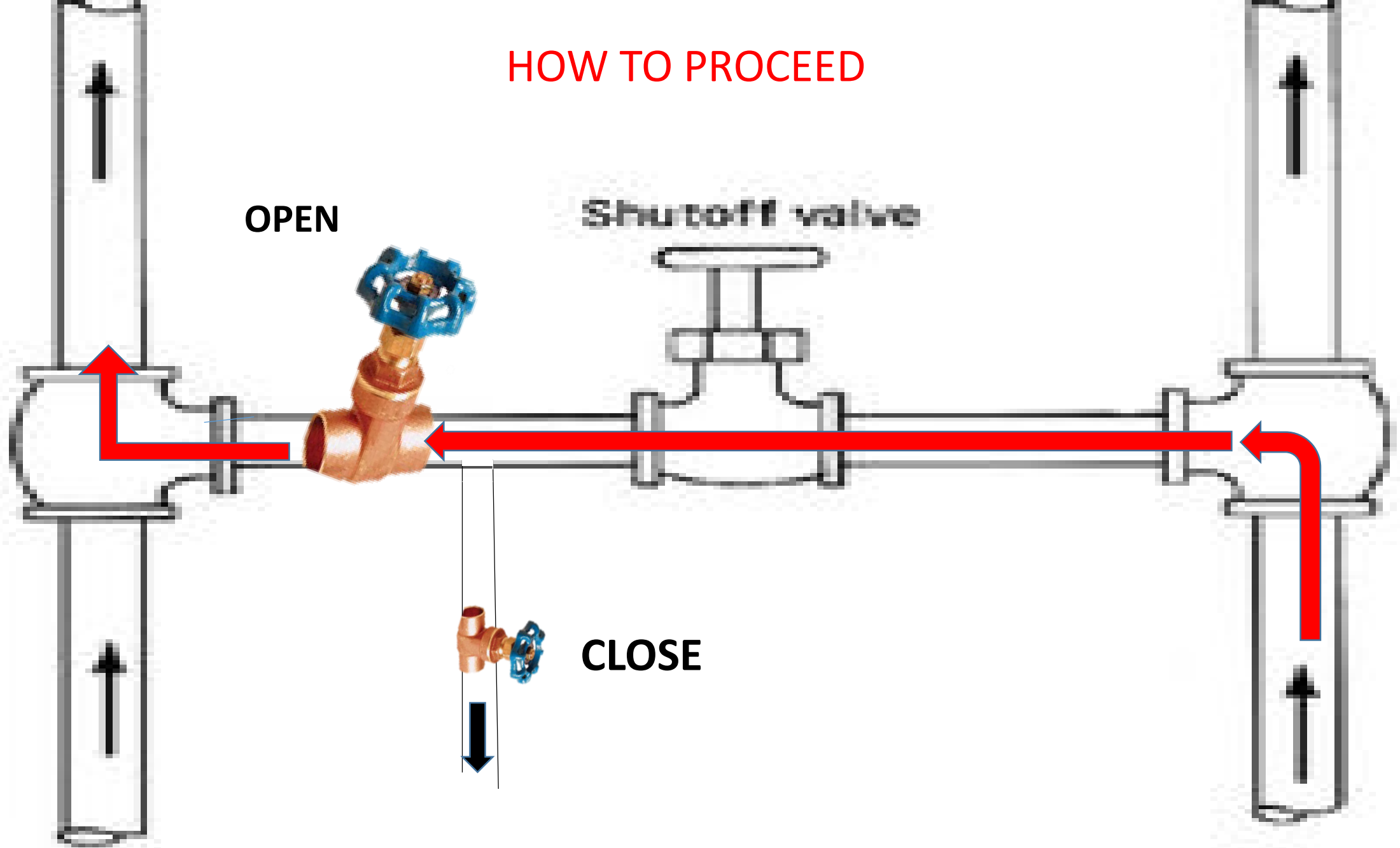
OPEN

Shutoff valve

CLOSE

Potable water COLD

HOT potable WATER



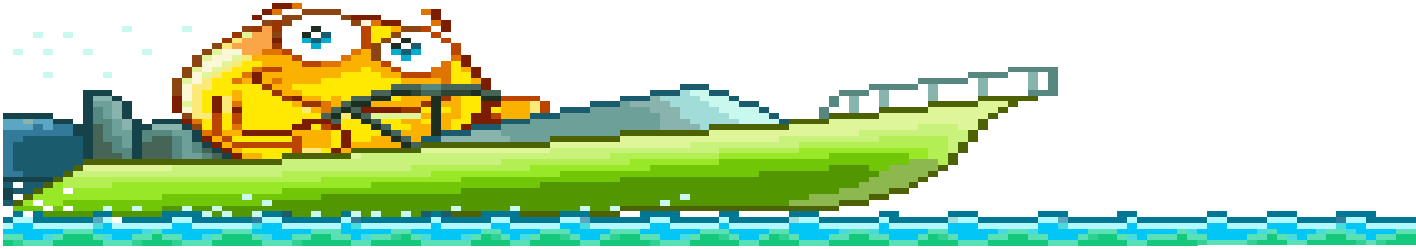
Plastic Pipe Material	Operating Temperature			
	With Pressure		Without Pressure	
	(°F)	(°C)	(°F)	(°C)
ABS - Acrylonitrilebutadiene Styrene	100	38	180	82
PE - Polyethylene	100	38	180	82
PVC - Polyvinylchloride	100	38	140	60
CPVC - Chlorinated Polyvinyl Chloride	180	82	180	82
PB - Polybutylene	180	82	200	93
PP - Polypropylene	100	38	180	82

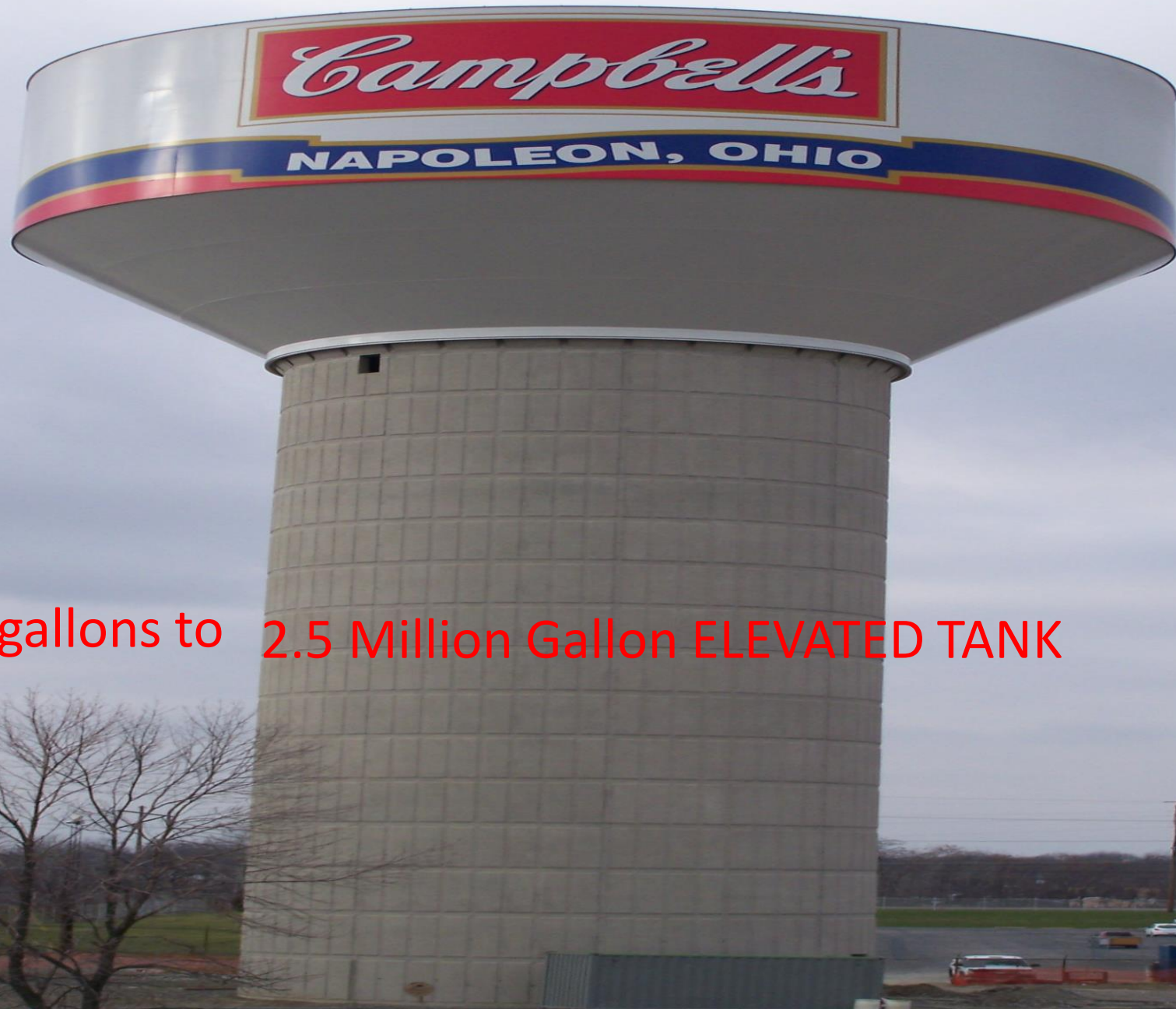
CHECK FOR INCOMPATIBILITY WITH PIPELINES

- HOT WATER
- DISINFECTANTS



During peak season 4 hours from skiing on the Maumee River to going inside a can of Soup !





From 100,000 gallons to 2.5 Million Gallon ELEVATED TANK

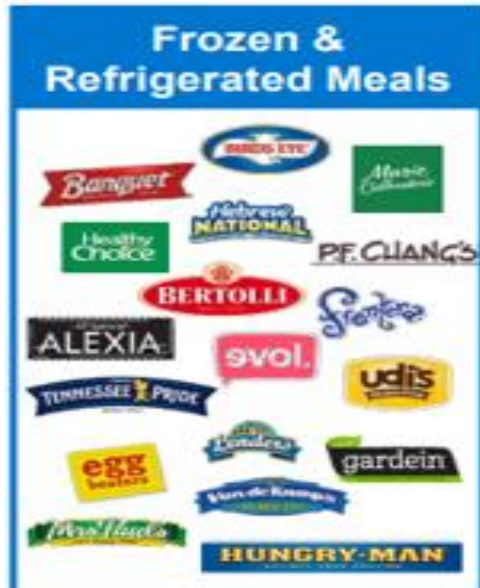


gettyimages
Bloomberg

THANK YOU



H₂O OPERATORS QUESTIONS



Mike Maringer

419 – 707 – 7559

mnmaringer400@gmail.com