



Water Distribution and Tank Mixing

Daryl Bowling

Utility Service: Overview



- Leading US provider of water tank asset management
- Manage over 6,000 water tank asset management programs
- Completed over 1,500 renovations in 2014
- More than 3,000 clients in over 42 states
- Perform over 8,000 condition assessments per year
- 300 employees - 44 field representatives geographically organized
- 10 Production & Logistic Centers

Utility Service: Services



- Tank Cleaning and Painting
- Chemical Cleaning
- TRS
- In Tank Mixing
- Ice Pigging water and waste water
- Metering AMI
- Filter Media clean/replace
- Water Well Service



Tank Mixing

Eliminate Water Storage???

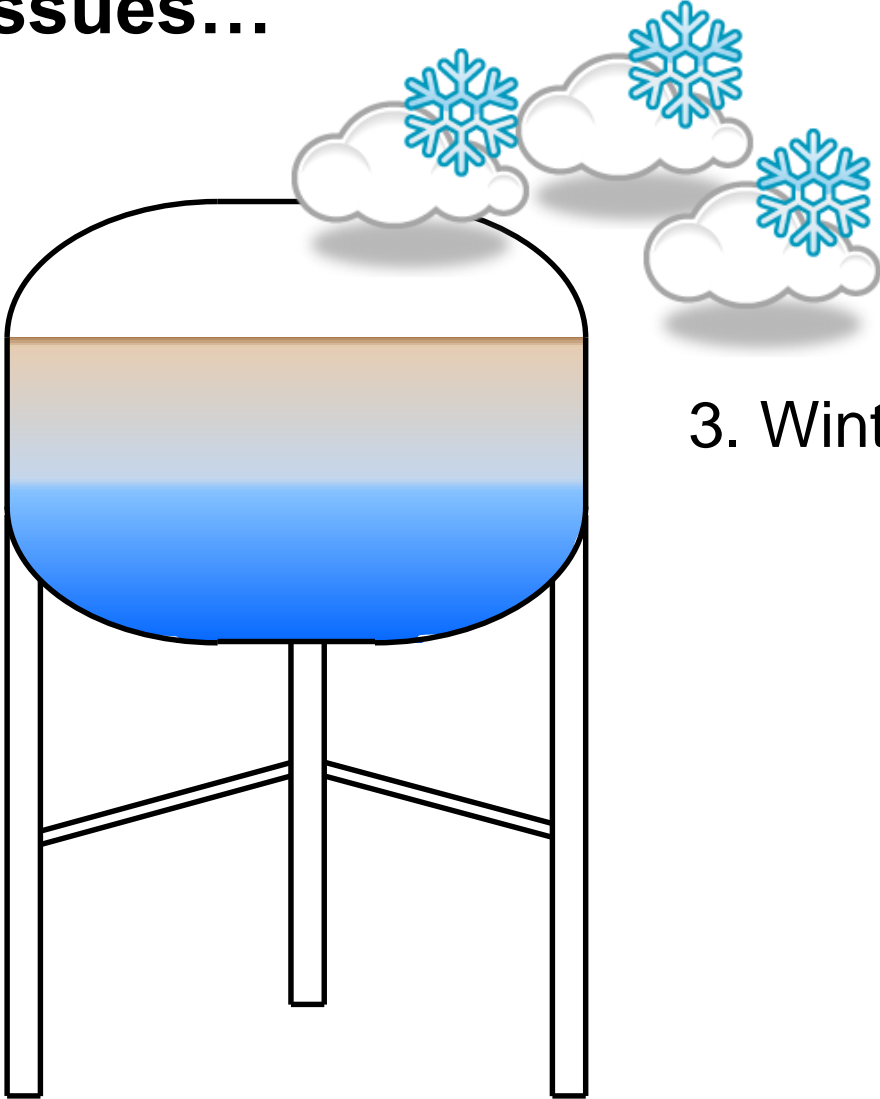


3 Primary Tank Issues...



1. Summer (heat)

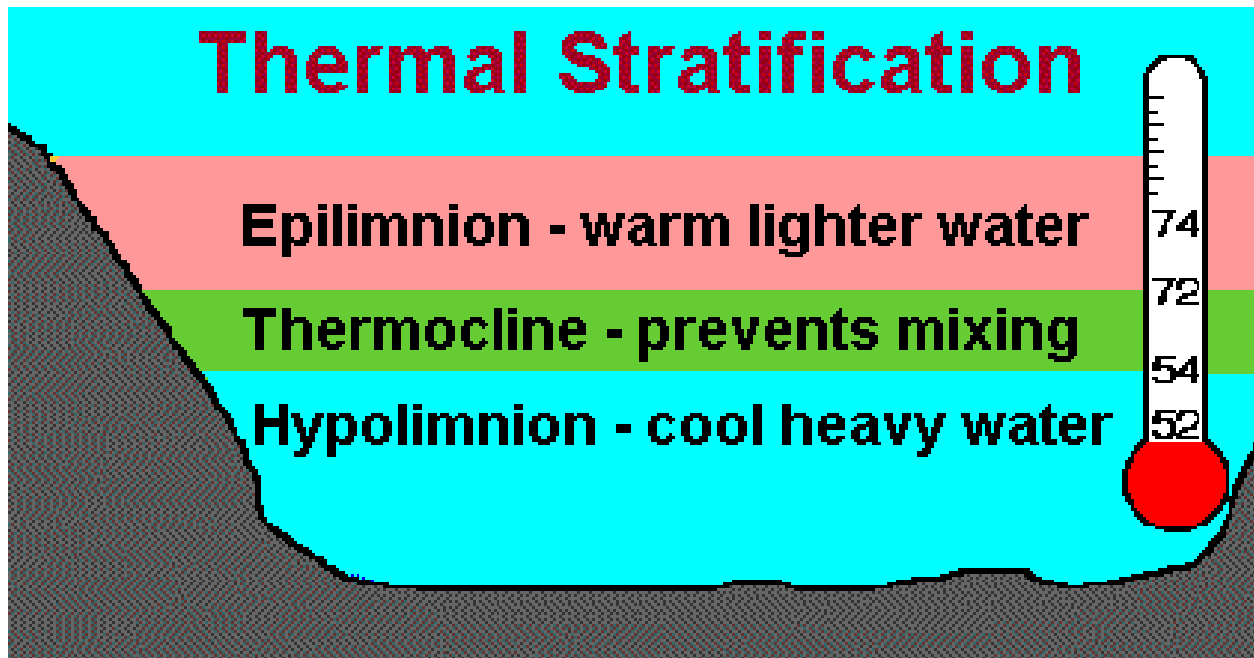
2. Low turn-over



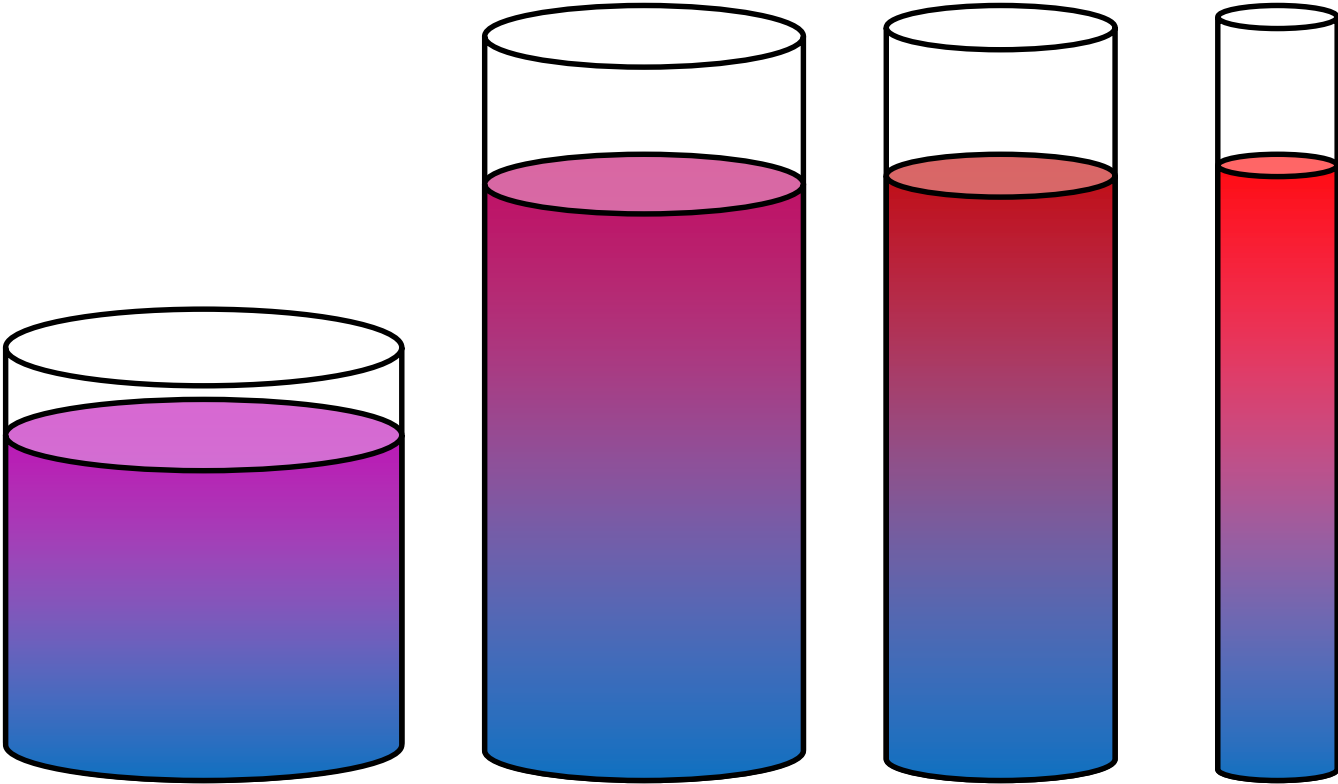
3. Winter (ice)

#1 Thermal stratification

- a leading cause of aging water



Thermal stratification problems get worse, as aspect ratio increases...

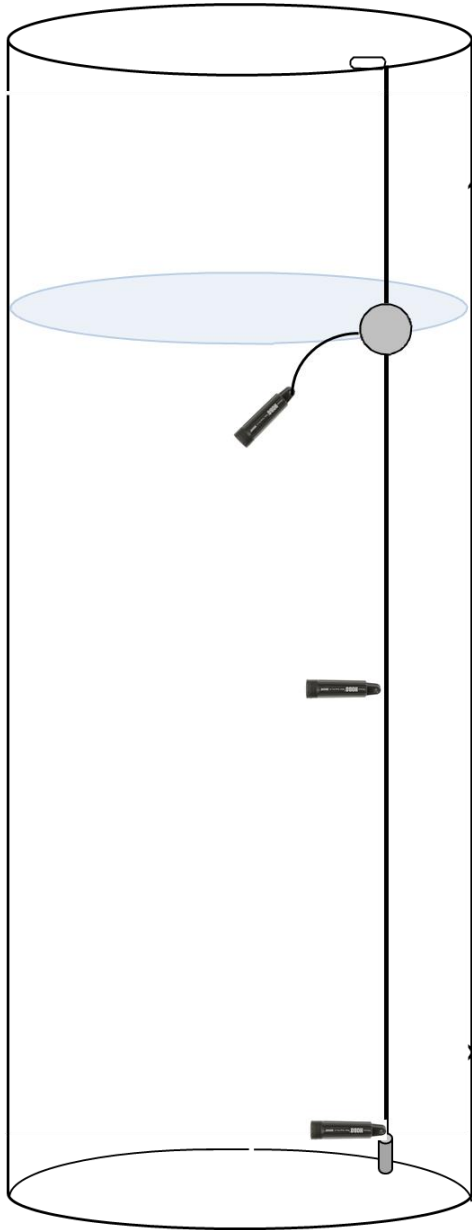


Higher surface area-to-volume ratio



Have you ever seen the condensation ring on a tank?

Temperature Probe testing



Float rides up and down with demand

316 SS Ball Float



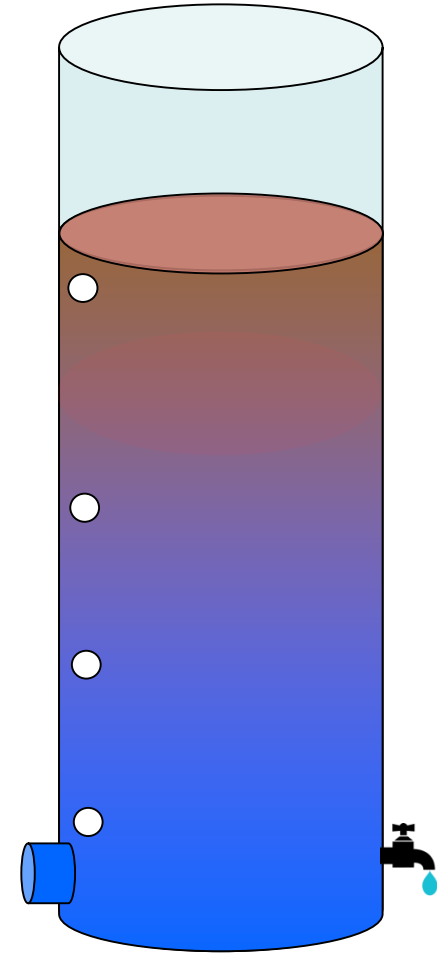
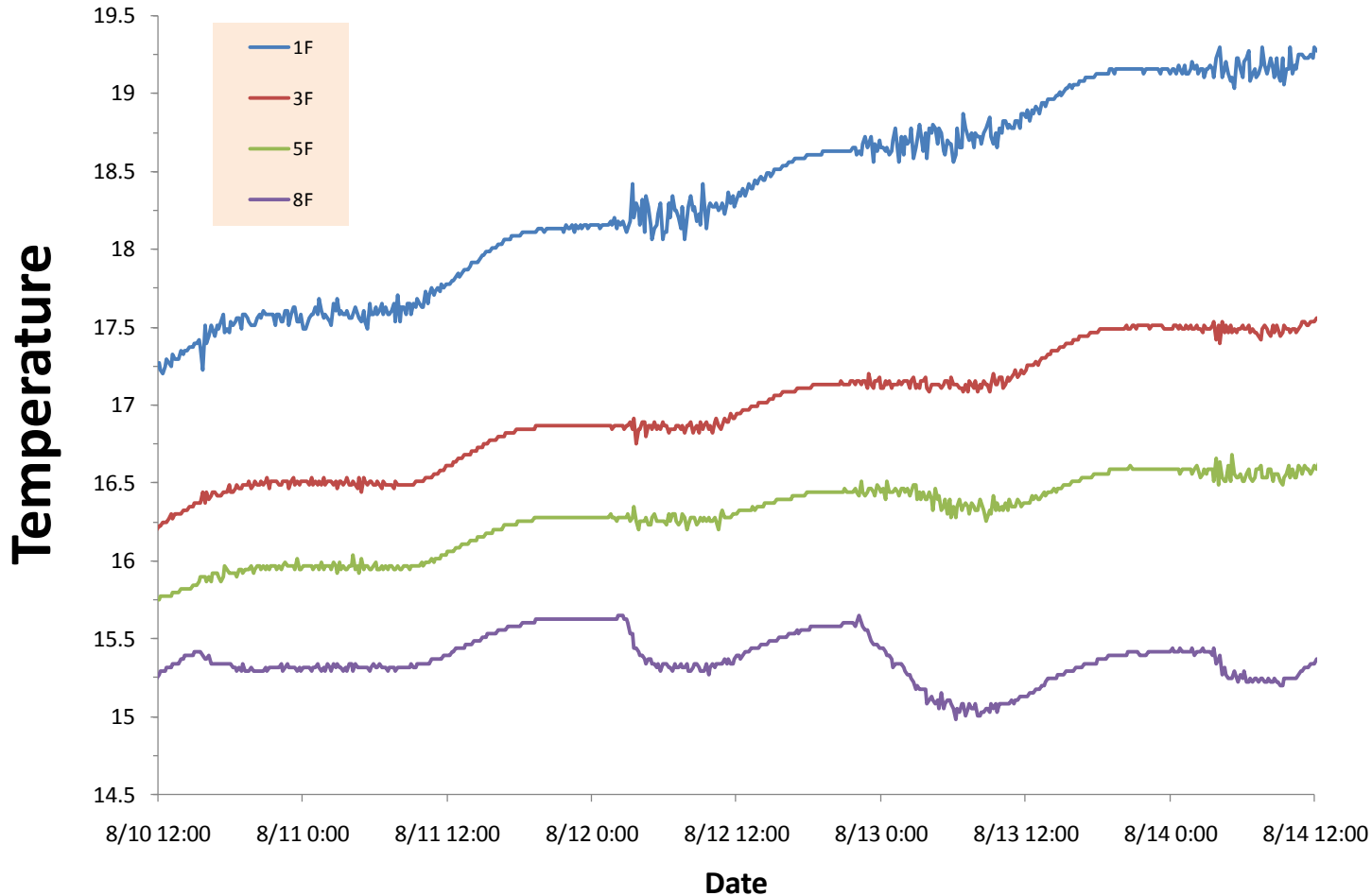
One Probe on bottom
One Probe in the middle
One Probe on top
Collect data every 10 minutes



316 SS Pear Clip Attachment & 316 SS Weight

For Example....

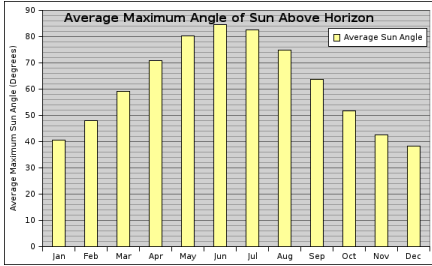
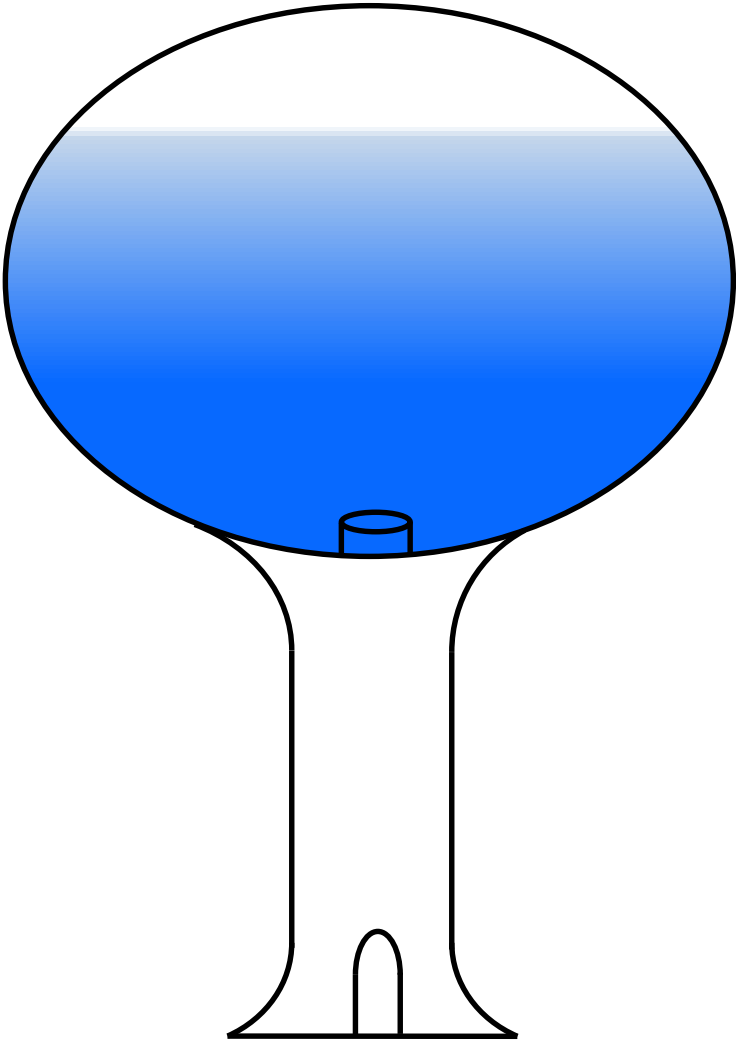
Water temperature and level, Cambridge tank , Mixer off



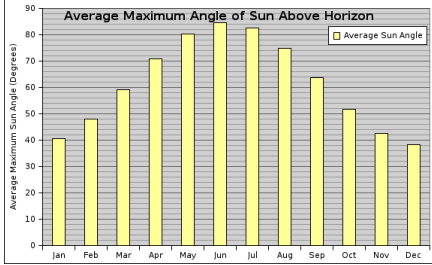
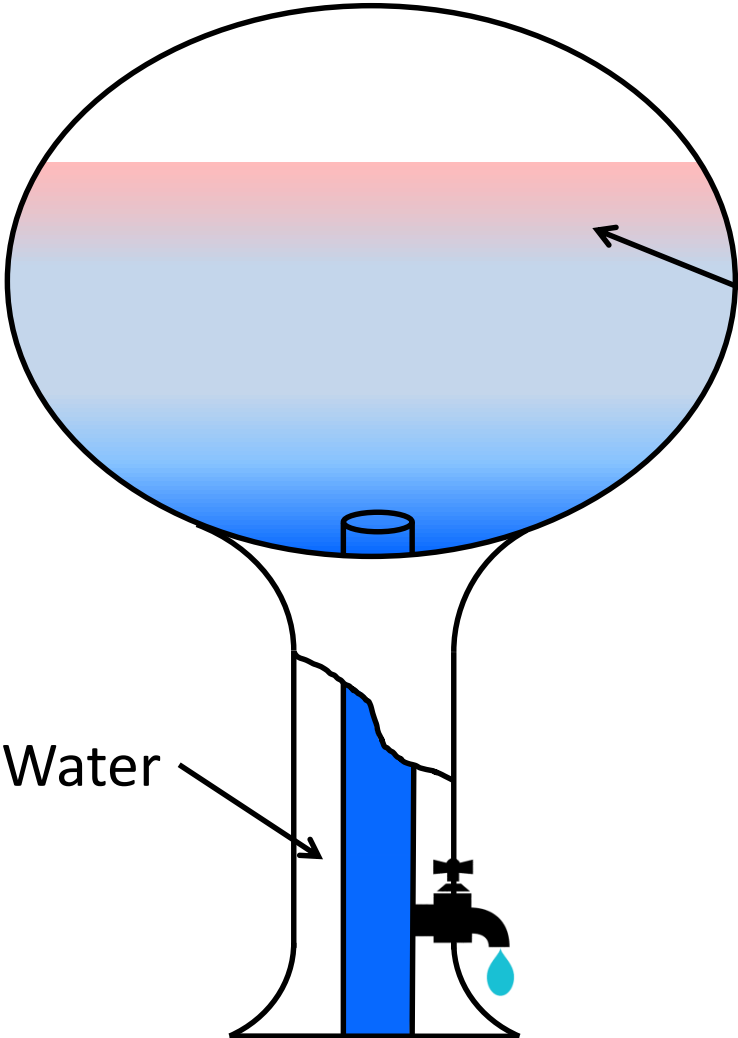
How does stratification happen?



Sun warms tank ...



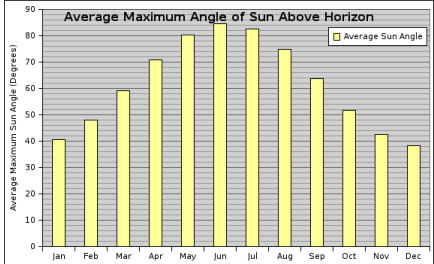
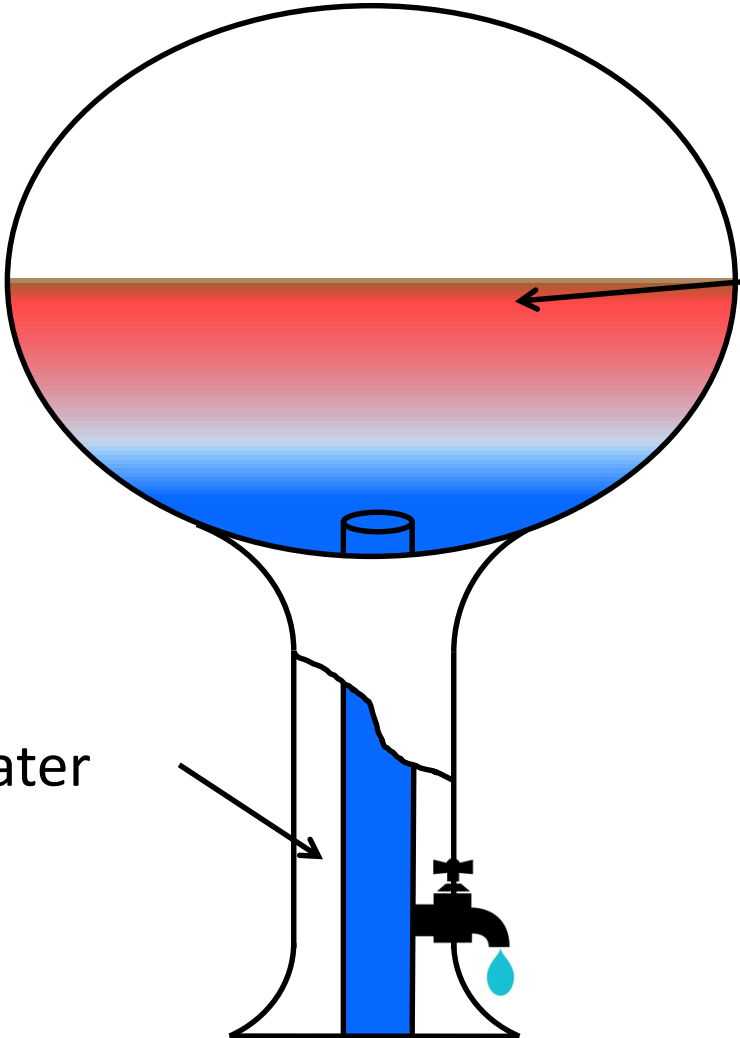
How does stratification happen?



70 F Surface Water

57 F Ground Water

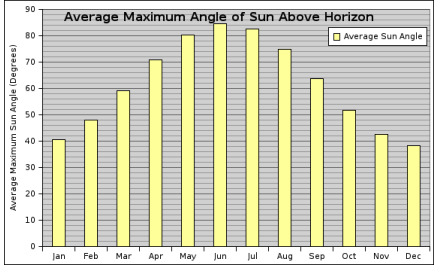
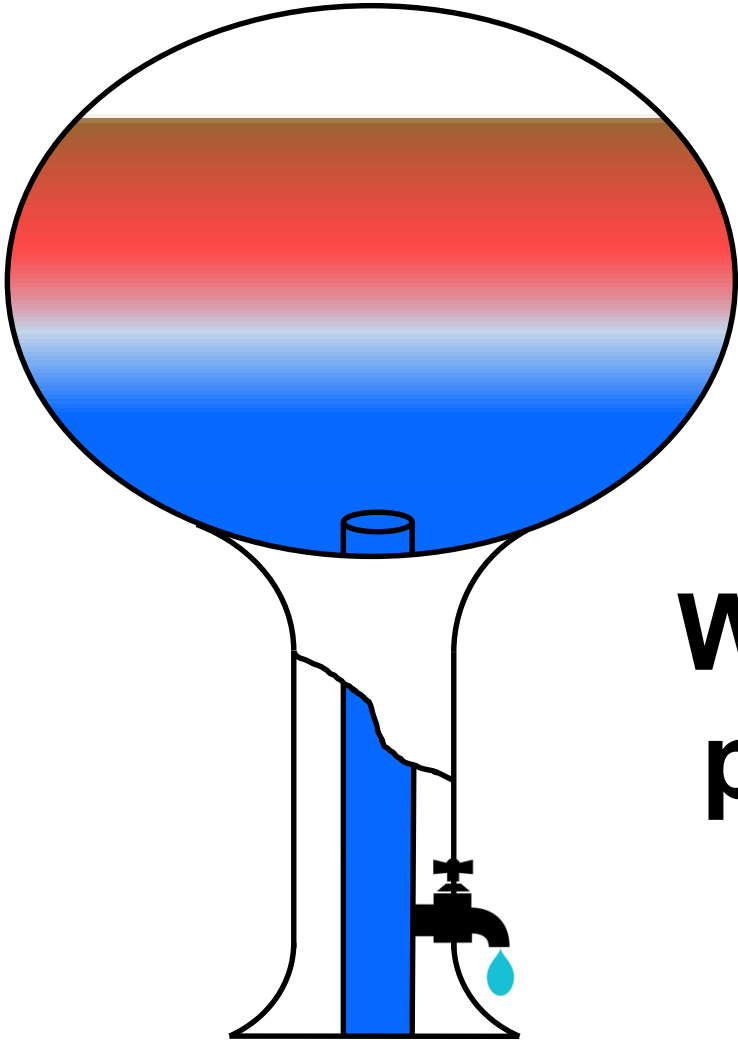
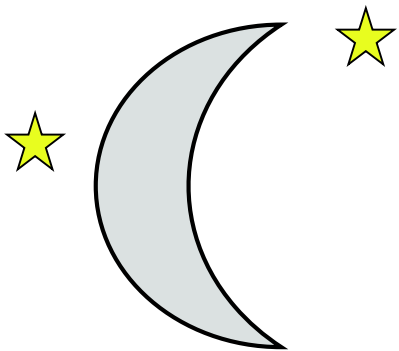
How does stratification happen?



75+ F Surface Water

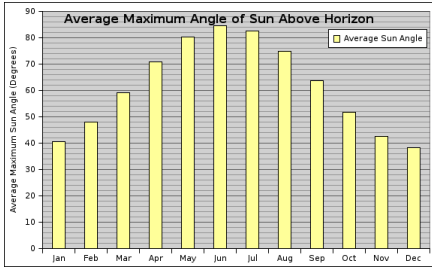
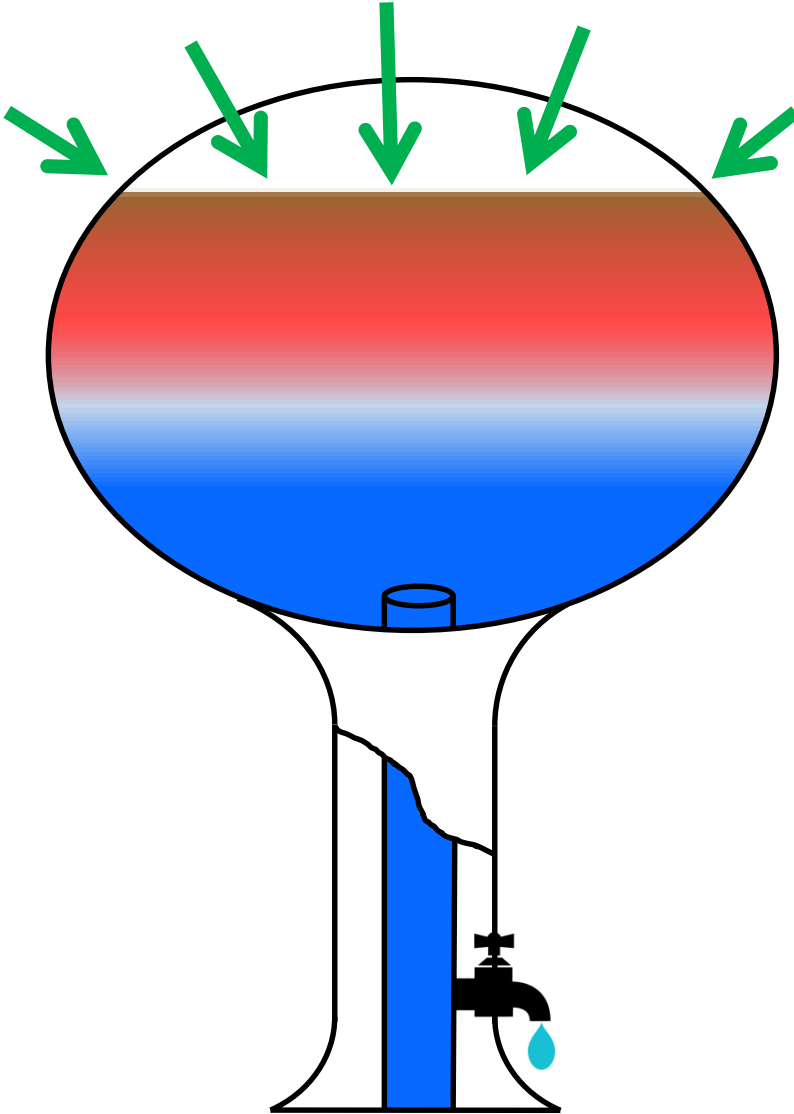
57 F Ground Water

How does stratification happen?

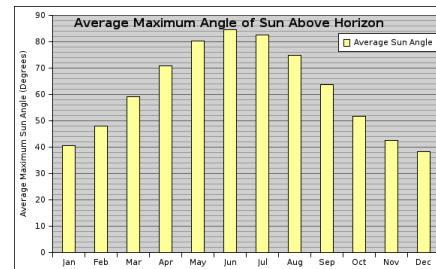
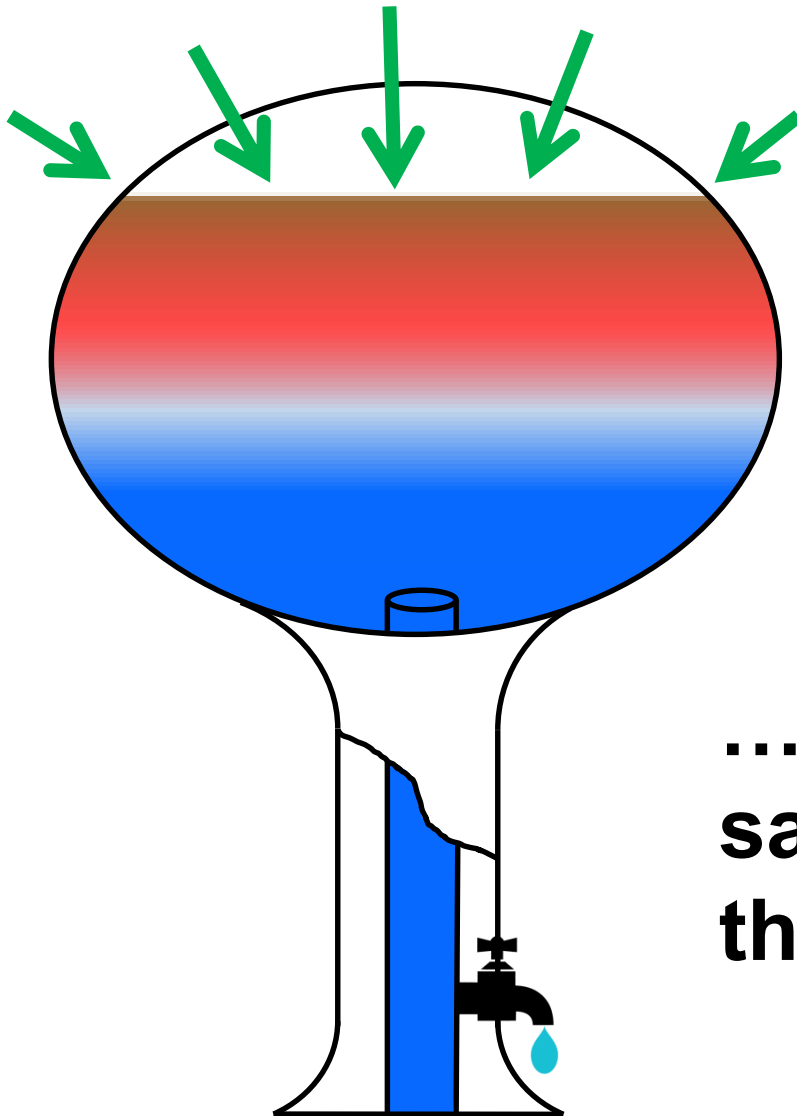


What's the problem?

Not Knowing What's Here!!!

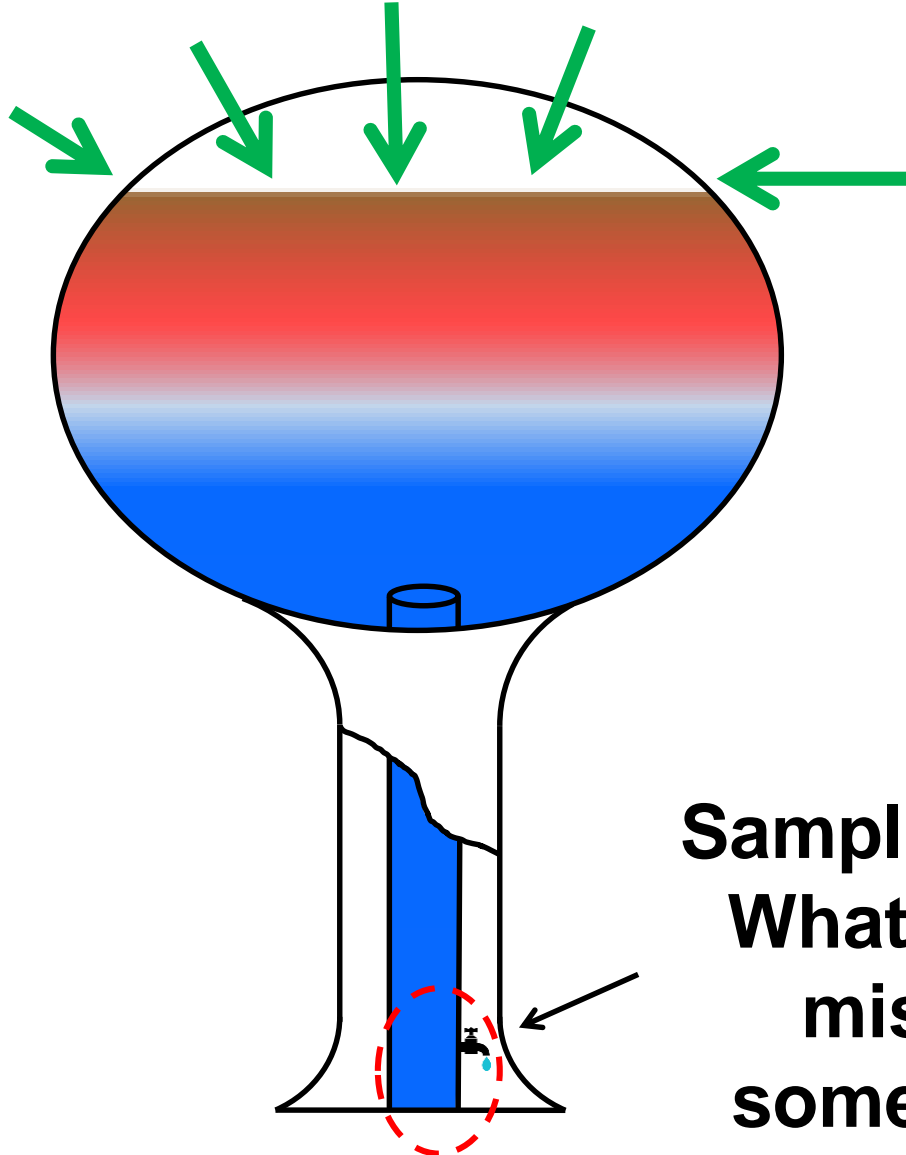


Not Knowing What's Here!!!



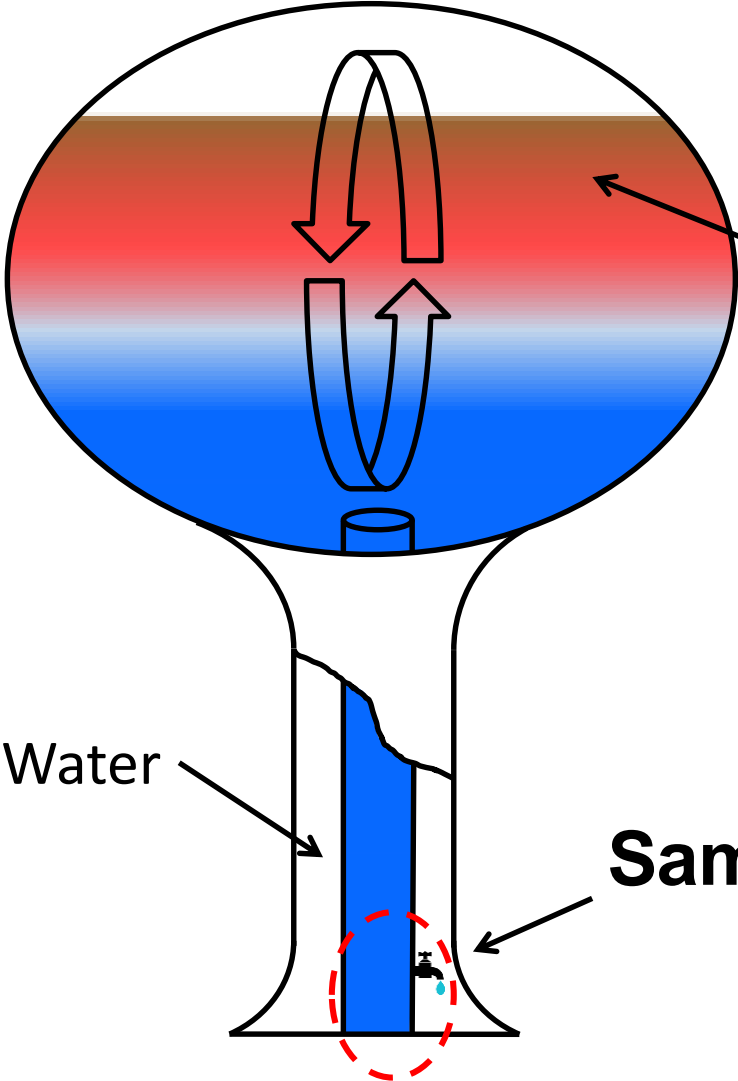
... but my
samples say
things are fine?

Not Knowing What's Here!!!



**Sampling 1%...
What if your
missing
something?**

Old water in distribution...

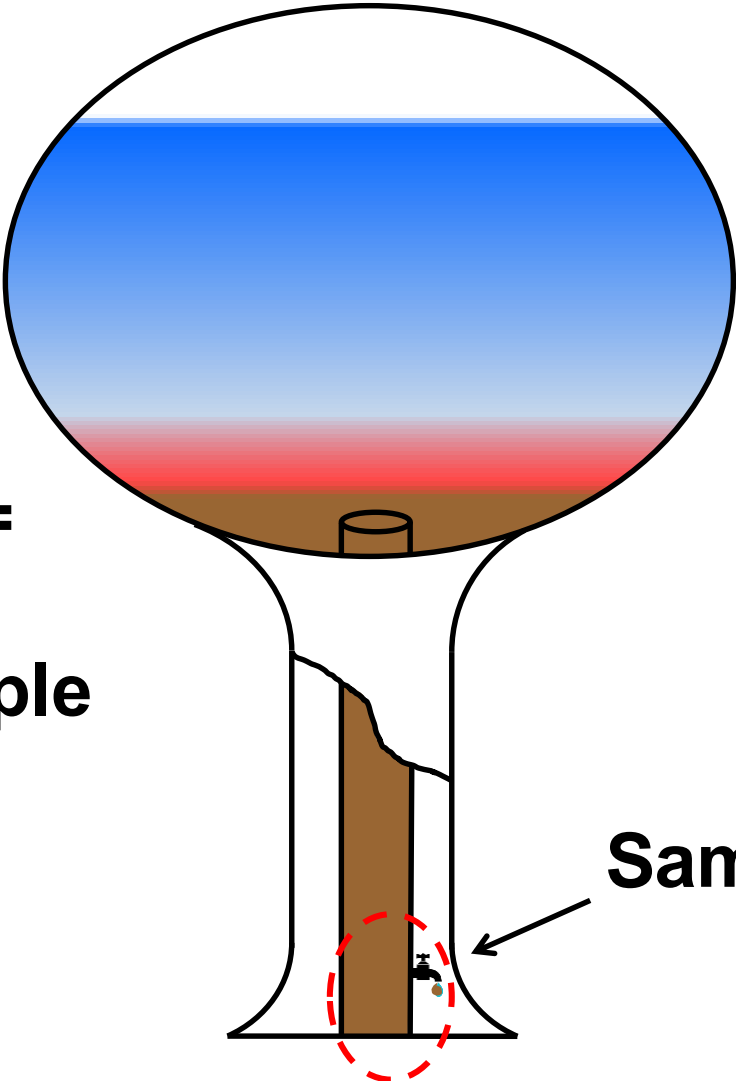


Seasonal Flip...
like a lake!
55 F Surface Water

57 F Ground Water

Sampling 1%...

Old water in distribution...



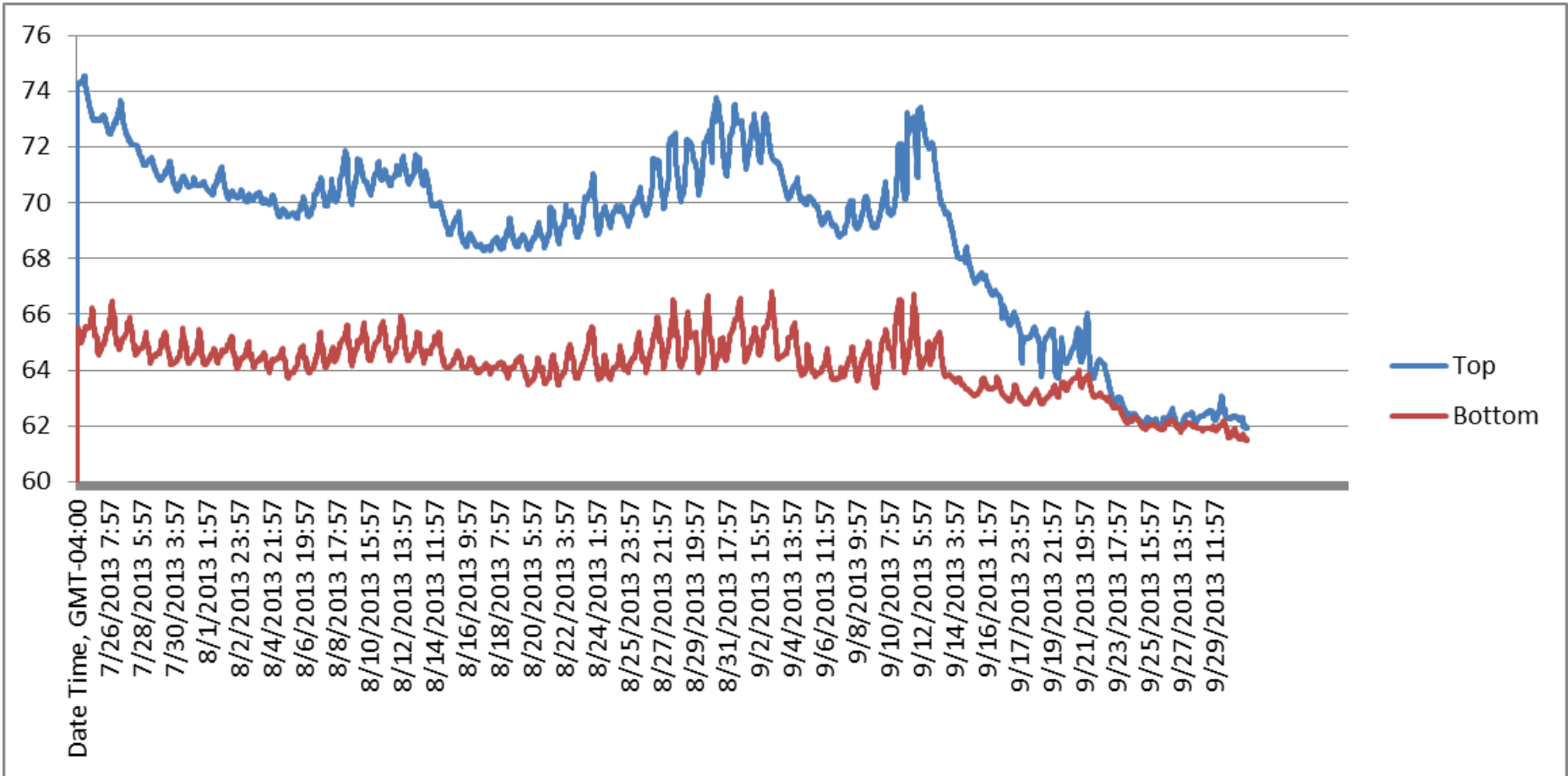
**Tank Flips =
Seasonal
“Funny” Sample**

Sampling 1%...

Thermal stratification



1 MG Hydro – 35 ft of water

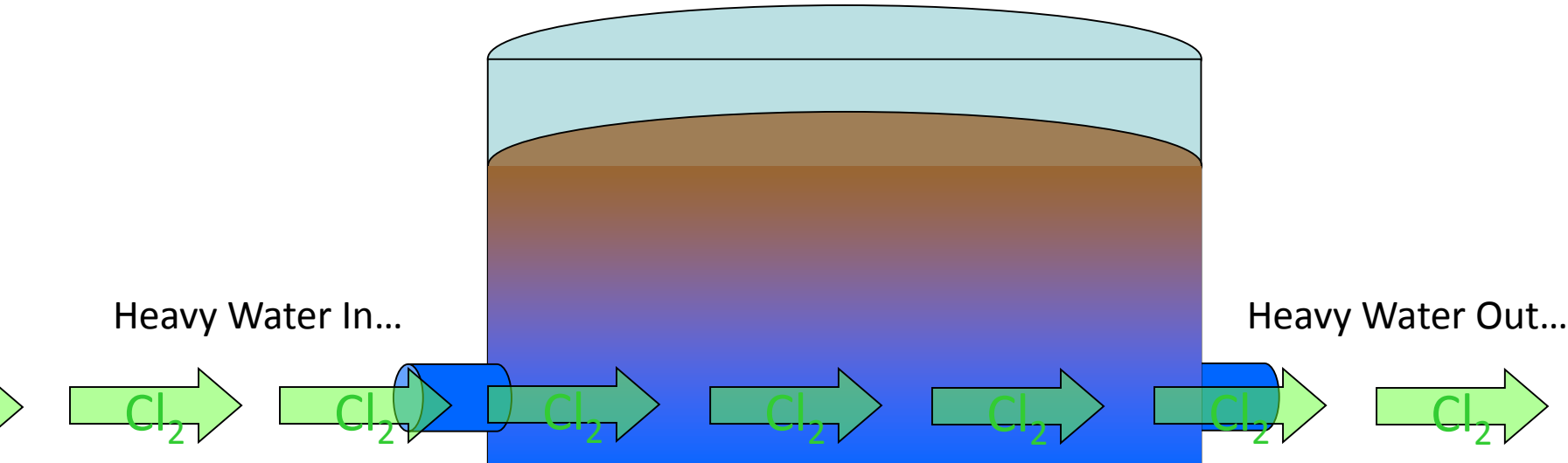


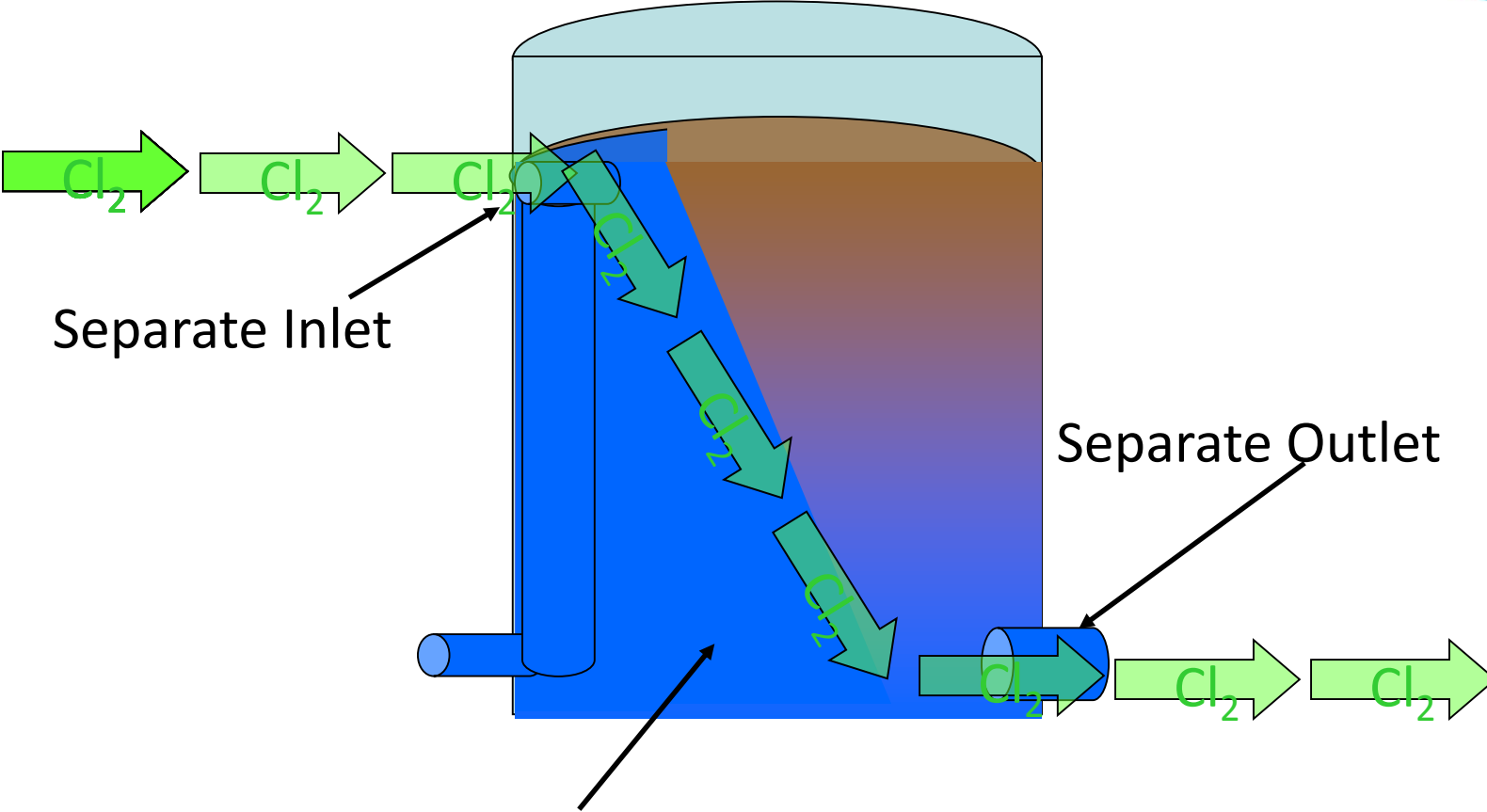
Grab samples taken from the top of the tank and also samples taken from the bottom.

Little to No chlorine was detected at the top of the tank

Hydraulic Work Around

Separate inlet/outlet may not help ...



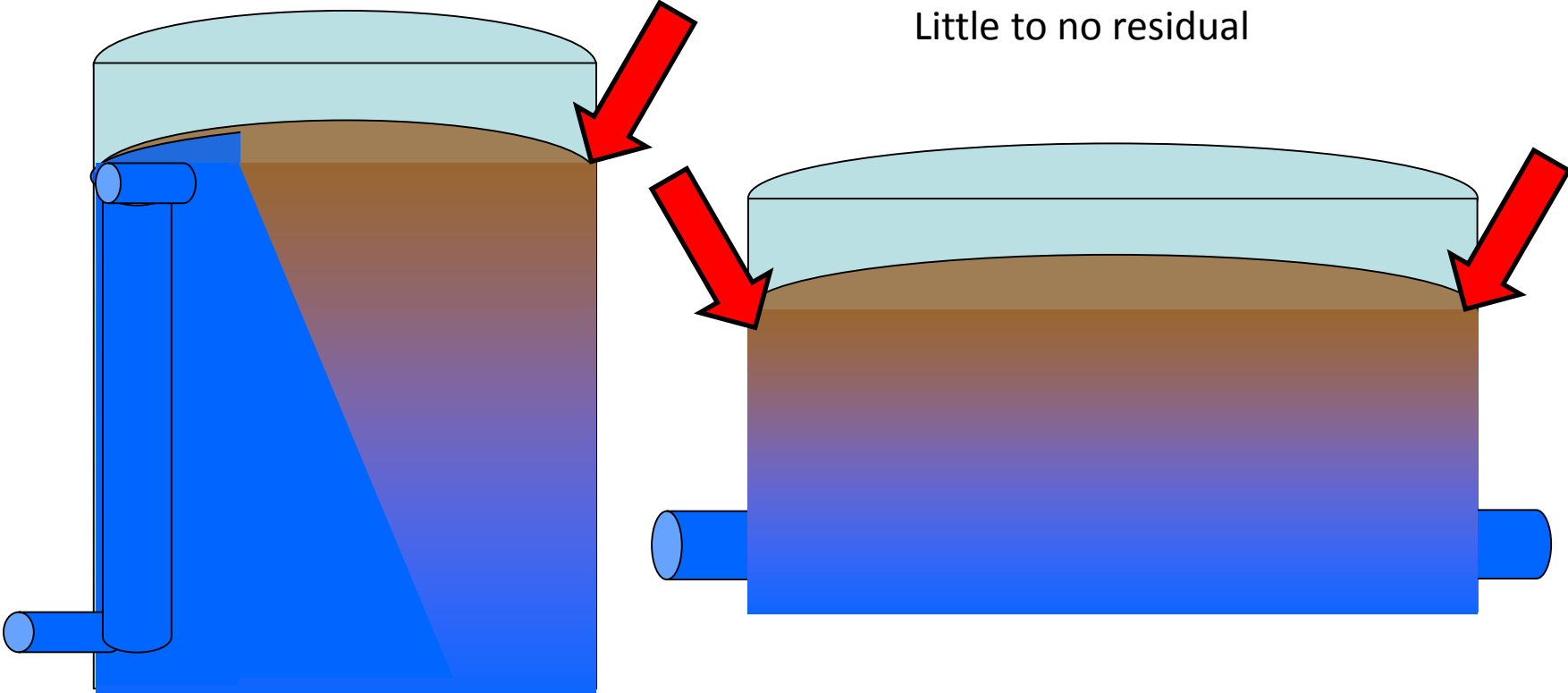


Colder, denser inlet water tends to sink (and not mix)

This is where Biofilm develops

Old Water

Little to no residual



BIOFILM?

- Bacterial cells
- Colonies they form
- Polysaccharide slime they deposit for protection



Bio-film?

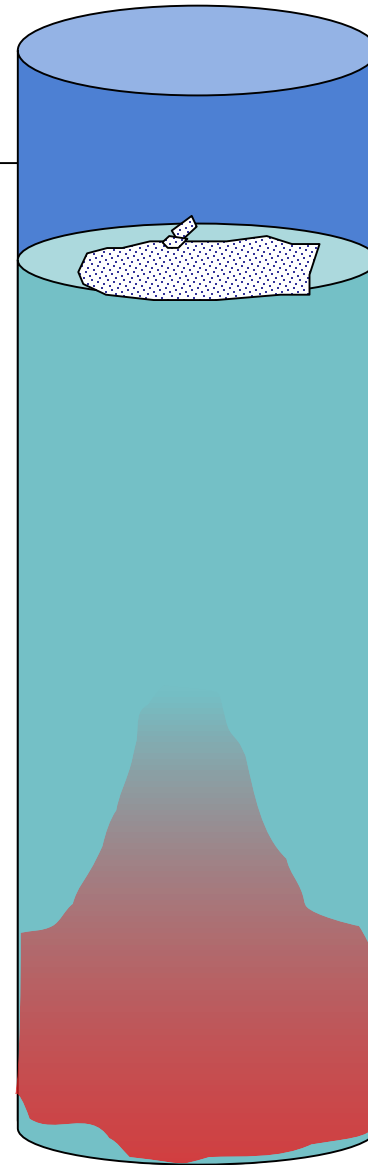


Common Cold Weather Pictures



Winter Water Quality

- Winter cold storms lead to frozen, stuck water (ice)

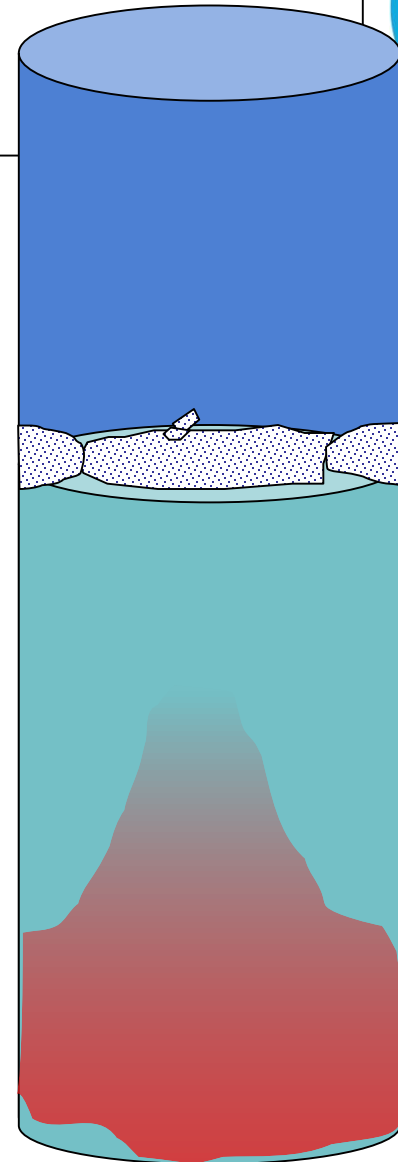


Standpip

Winter Water Quality

Utility
Service
Group

- Winter cold storms lead to frozen, stuck water (ice)
- Ice begins to build

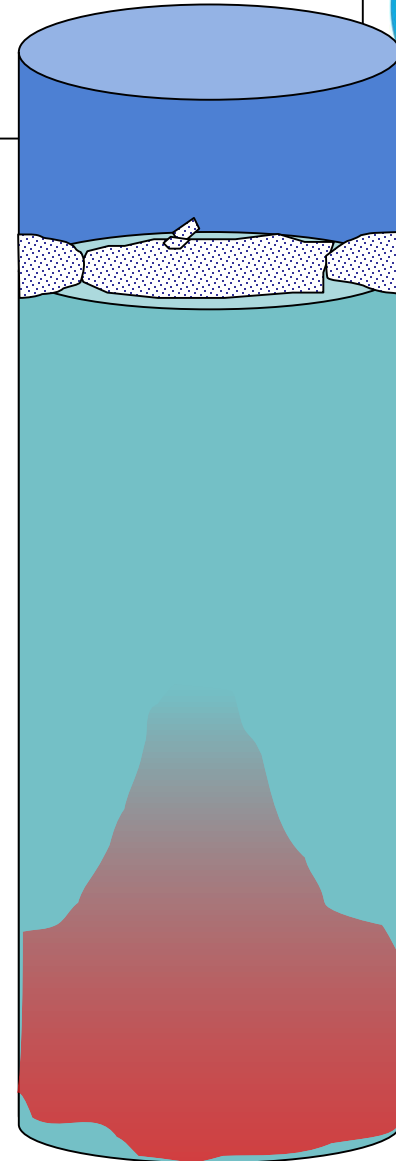


Standpipe

Winter Water Quality

Utility
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- Winter cold storms lead to frozen, stuck water (ice)
- Ice begins to build
- Water levels fluctuate

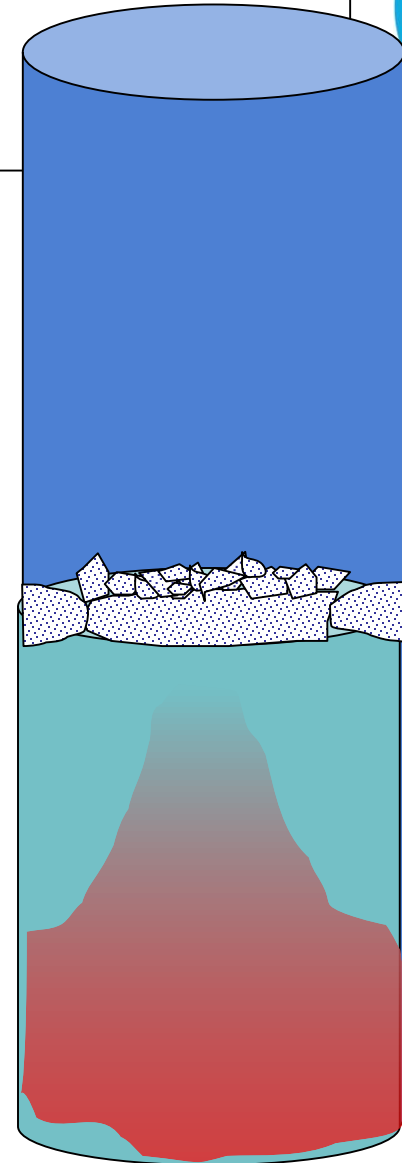


Standpipe

Winter Water Quality

Utility
Service
Group

- Winter cold storms lead to frozen, stuck water (ice)
- Ice begins to build
- Water levels fluctuate
- Ice thickens
- Inlet water stays at bottom

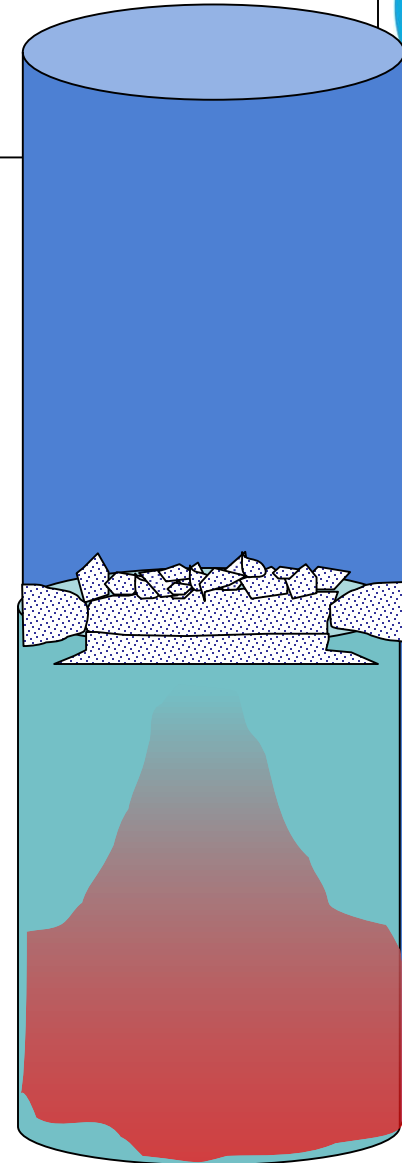


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Winter Water Quality

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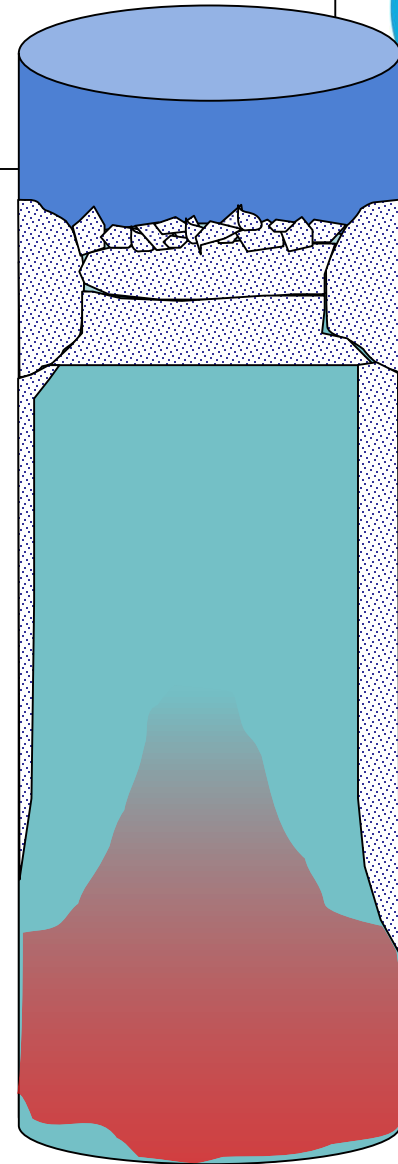


Standpipe

Winter Water Quality

Utility
Service
Group

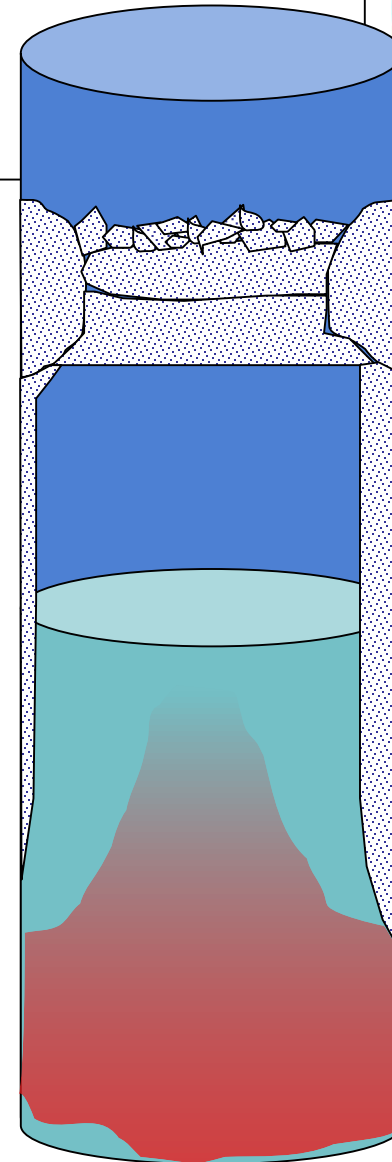
- Winter cold storms lead to frozen, stuck water (ice)
- Ice begins to build
- Water levels fluctuate
- Ice thickens
- Inlet water stays at bottom
- Heavy accumulation



Standpipe

Winter Water Quality

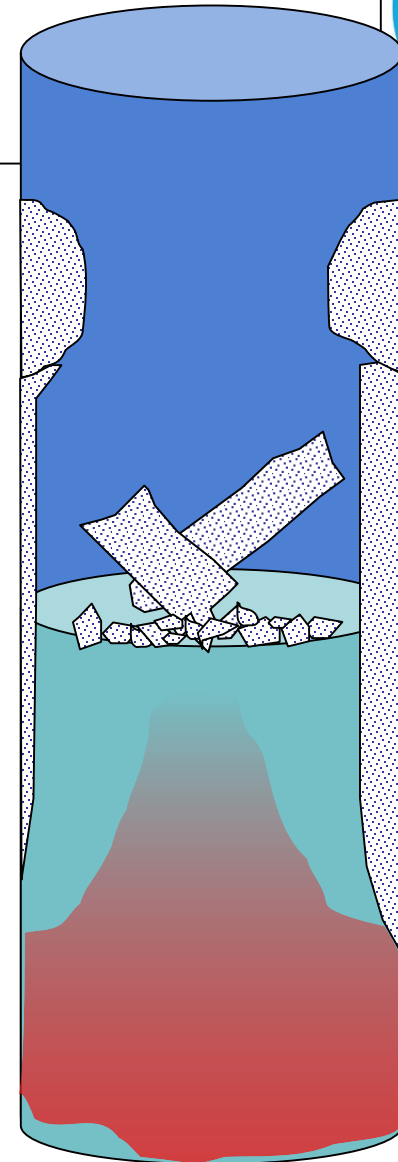
- Winter cold storms lead to frozen, stuck water (ice)
- Ice begins to build
- Water levels fluctuate
- Ice thickens
- Inlet water stays at bottom
- Heavy accumulation
- Water level fluctuates



Standpipe

Winter Water Quality

- Winter cold storms lead to frozen, stuck water (ice)
- Ice begins to build
- Water levels fluctuate
- Ice thickens
- Inlet water stays at bottom
- Heavy accumulation
- Water level fluctuates
- **Plug collapses!**



Standpipe

Cold Weather Tank Issues



Cold Weather Tank Issues



Other Winter Issues

- Ice expansion
- Punctures



Cold Weather Tank Issues



Other Winter Issues

- Ice expansion
- Punctures



Cold Weather Tank Issues



Other Winter Issues

- Ice expansion
- Punctures



Cold Weather Tank Issues



Cold Weather Tank Issues



Cold Weather Tank Issues



Cold Weather Tank Issues



Cold Weather Tank Issues

Utility
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Cold Weather Tank Issues



Cold Weather Tank Issues

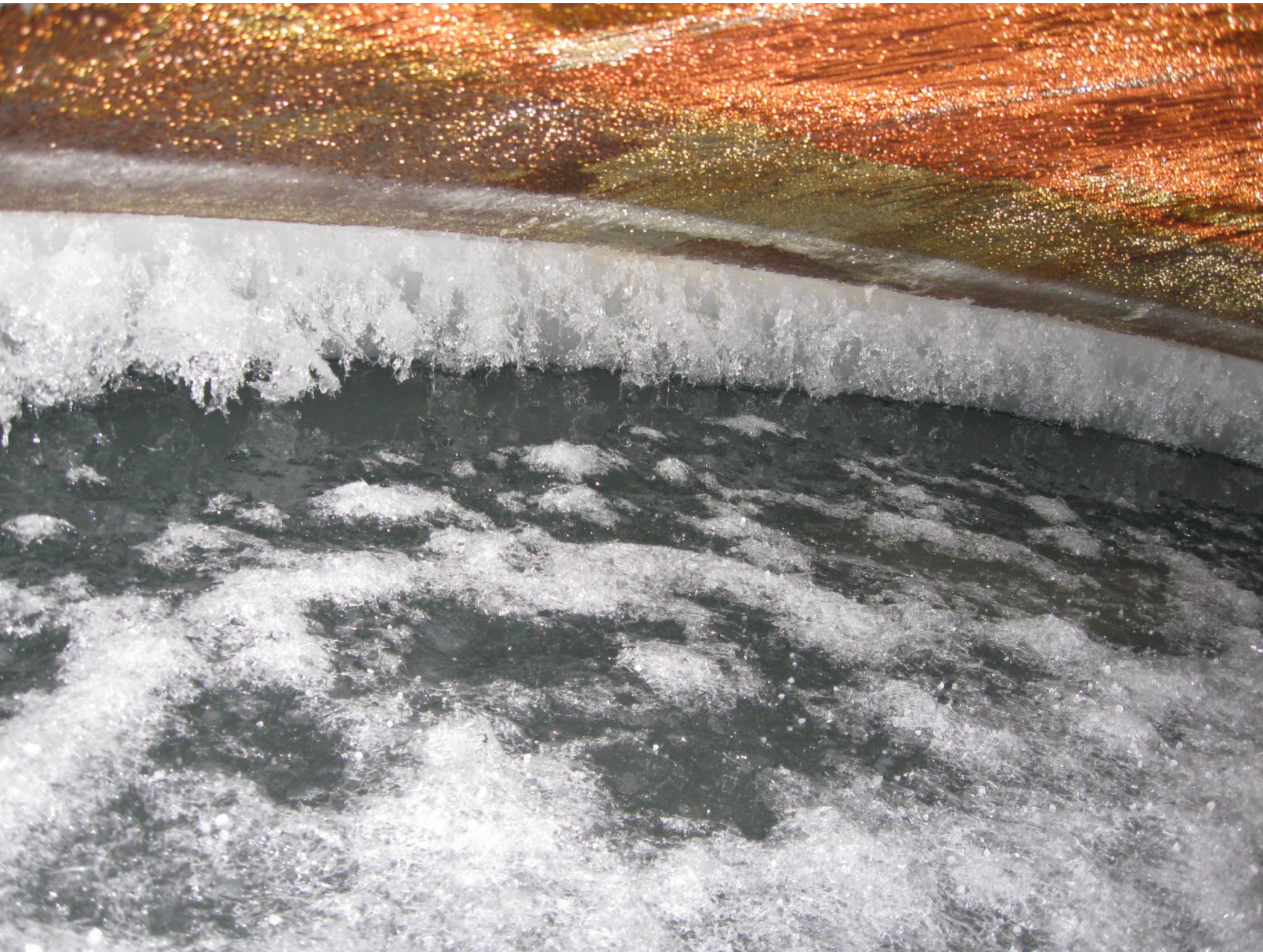
Utility
Service
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Coatings



Coatings



Coatings



Coatings



Coatings

Utility
Service
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Coating Damage Leading to Leak



Coating Damage Leading to Leak



Last winter in Northwest Ohio

Utility
Service
Group



Last winter in Northwest Ohio





Better Water Through Technology...



Mixing Technologies

Nozzles
“Passive”



1995

Draft Tube
“Active”



2000

Active Mixer
“Active”



2005

Timeline showing when solutions became available ...



Biomimicry



Biomimicry



Is an approach to innovation that seeks sustainable solutions to human challenges by emulating nature's time-tested patterns and strategies.



Lily Impeller

Super Nature | Biomimicry

 Photo |  Video

[Information](#) [Full Caption](#) [Permalink](#)


Lily Impeller. Prototype. 1996

Jayden D. Harman (Australian, b. 1949)

PAX Scientific, Inc. (USA, est. 1997)

The Lily Impeller is a mixer “designed using the elegant and effective geometries found in natural fluid flow,” explains its designer. Its shape, based on the logarithmic curve known as the Fibonacci spiral found in nautilus shells and whirlpools, accommodates a centripetal flow of liquid with little friction. As a result the device is capable of circulating millions of gallons of water with a minimal amount of energy. Used in municipal reservoir tanks, the mixer prevents drinking water from stagnating, reducing the need for disinfectant additives.

 nature

 energy

 Return





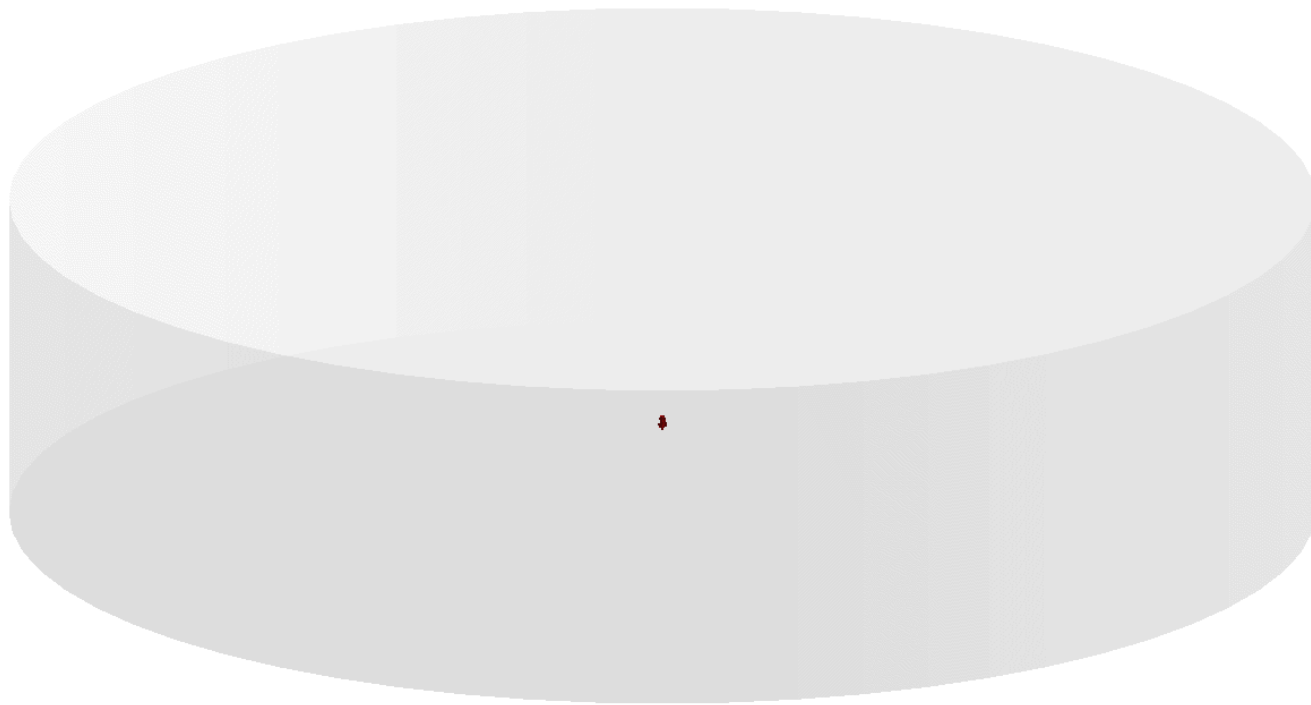
2014 – Jet Mixer Introduced

Produces powerful vortex jet: like rifling of a bullet



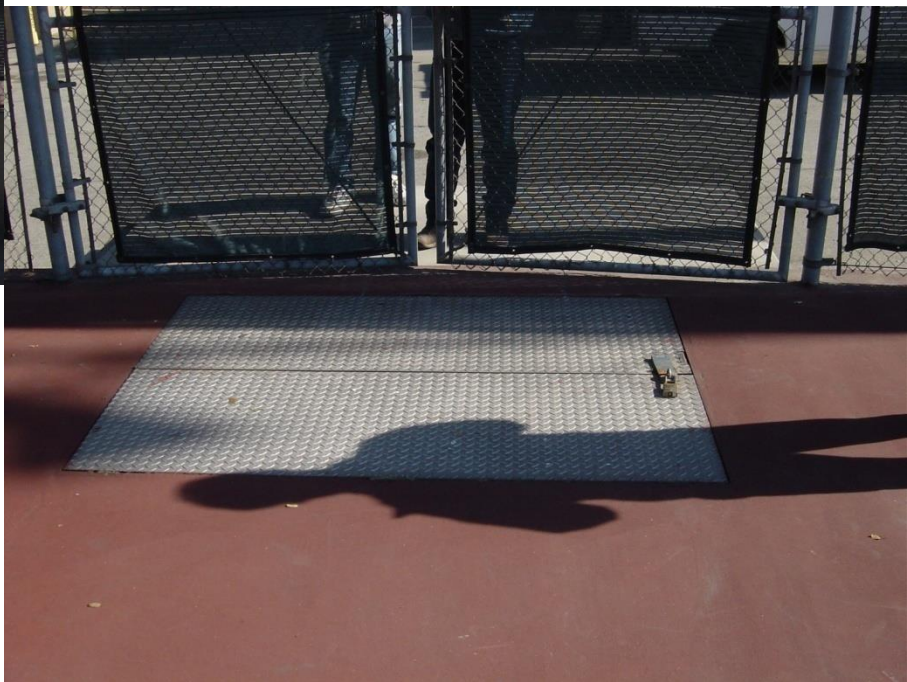
Jet mixer can mix up to 750,000 gallons

1. Flow Pattern



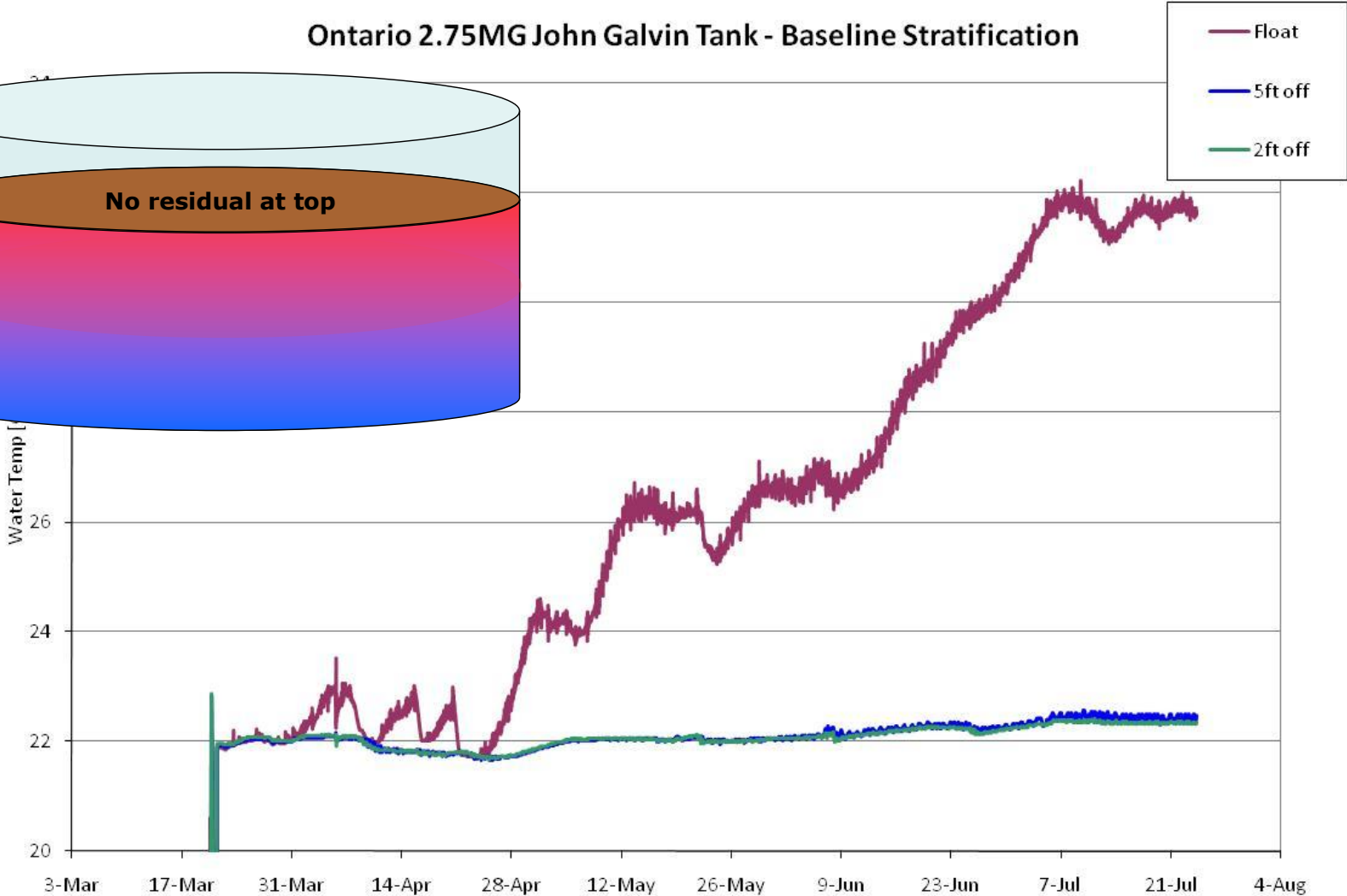
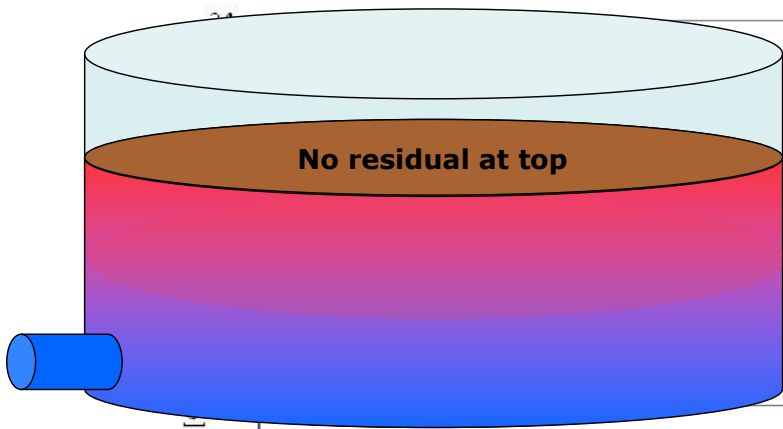


Case Studies: Active Mixing



2.75MG Concrete Tank (140x140x19ft)

Ontario 2.75MG John Galvin Tank - Baseline Stratification



(Figure 2). The reservoir dimensions are 140'x140'x19' and the water level considered was 19', corresponding to a volume of about 2.75 million gallons of water. The reservoirs have also 36 supporting columns.

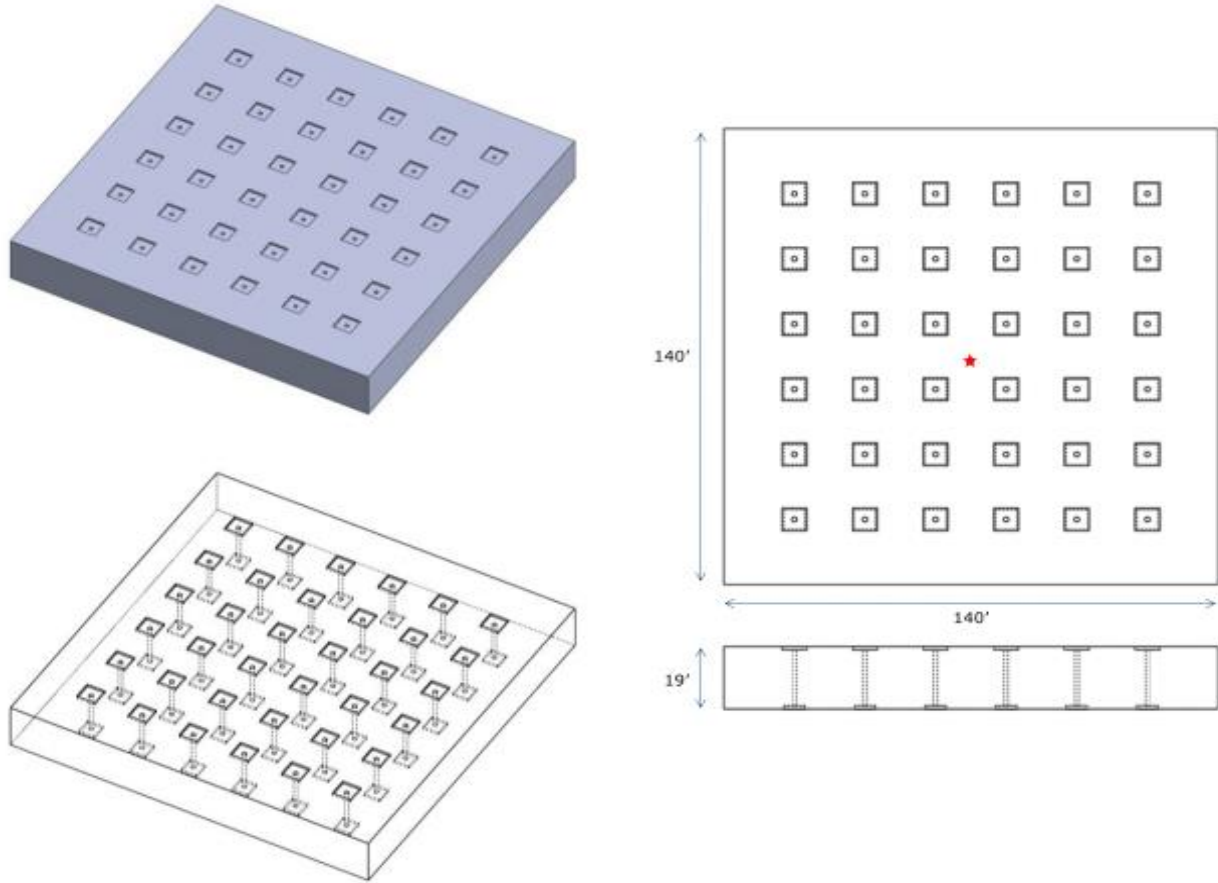
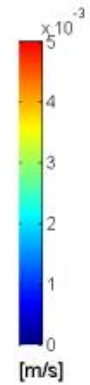
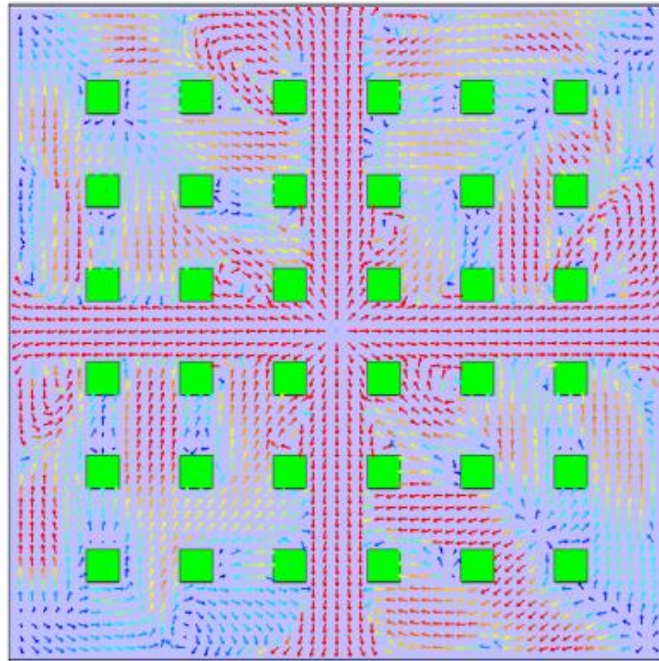
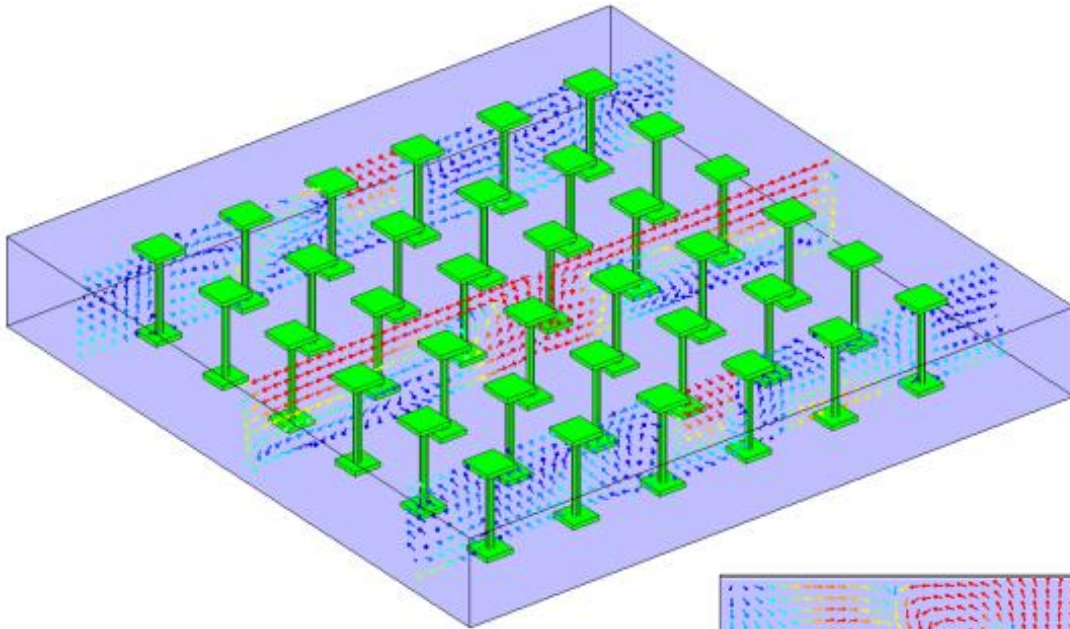
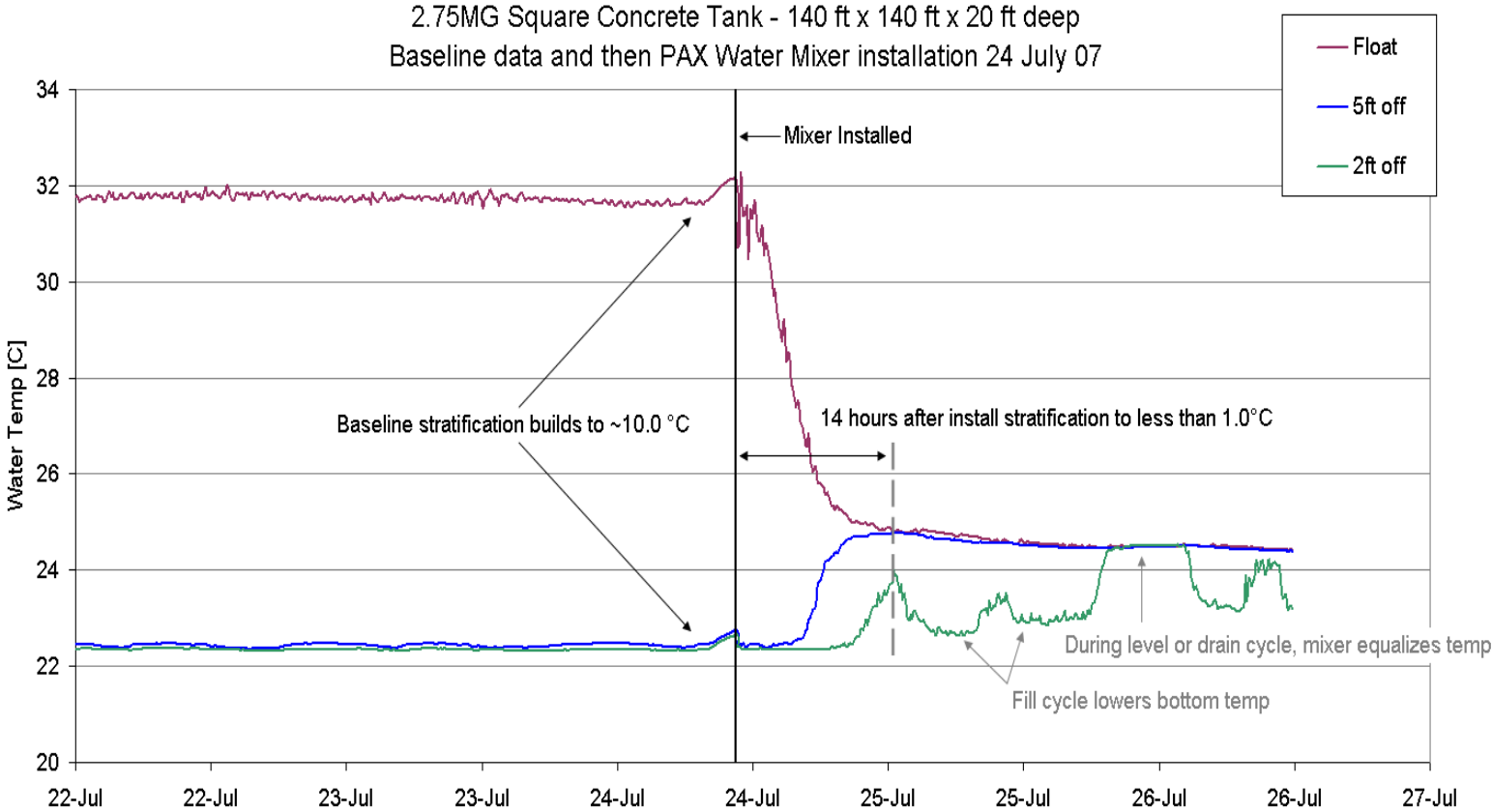


Figure 2: 3D CAD model and dimensions of the volume occupied by the water. The red star indicates the position of the PAX mixer.

A)

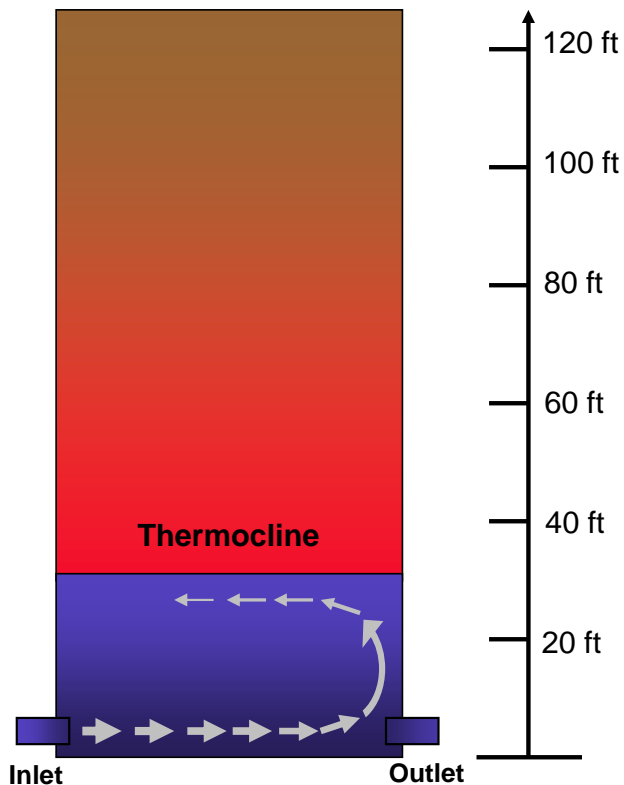


Mixer eliminates stratification



127 ft standpipe

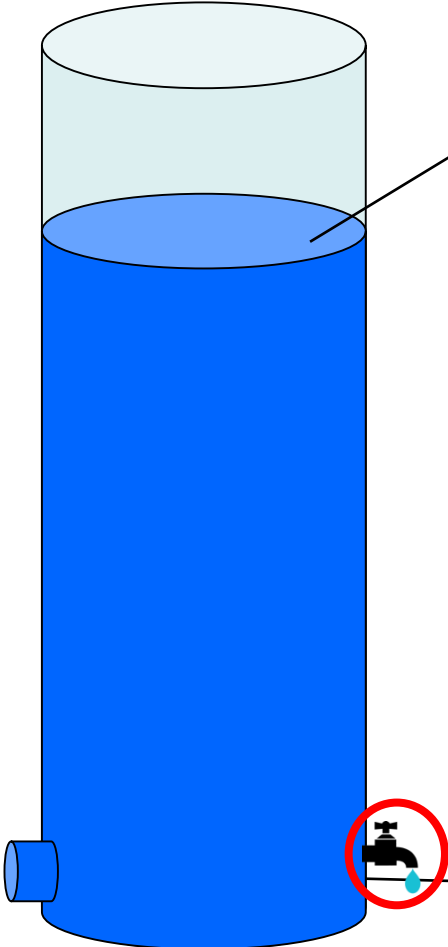
Condensation was visible up to approximately 24 feet above ground. But top of water was around 110 feet...



Chemical Measurements

Total Chlorine samples taken

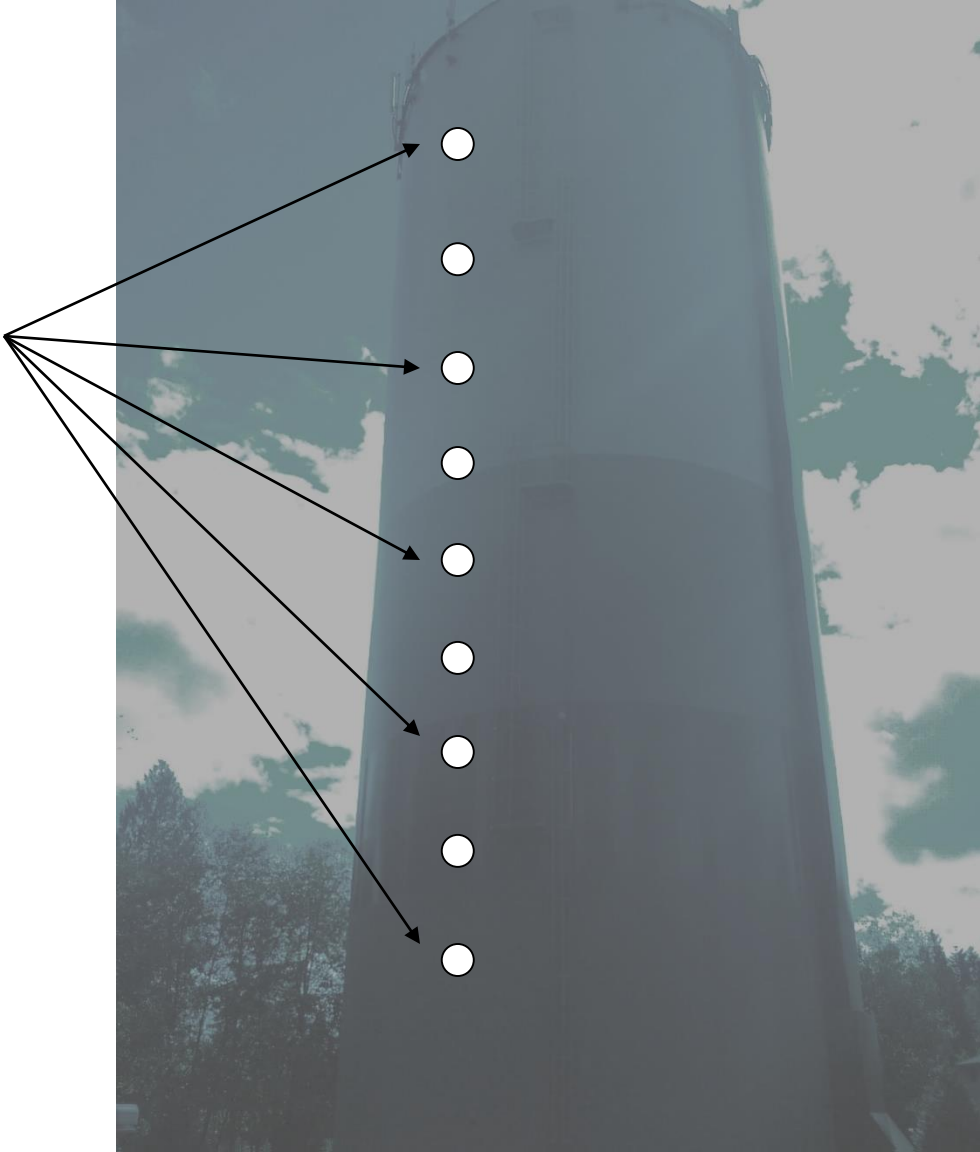
- top of tank (through hatch)
- bottom of tank (at sample tap)



Temperature Measurement

- Temperature string installed with sensors at different depths...
 - float
 - 80 ft off bottom
 - 60 ft off bottom
 - 40 ft off bottom
 - 20 ft off bottom

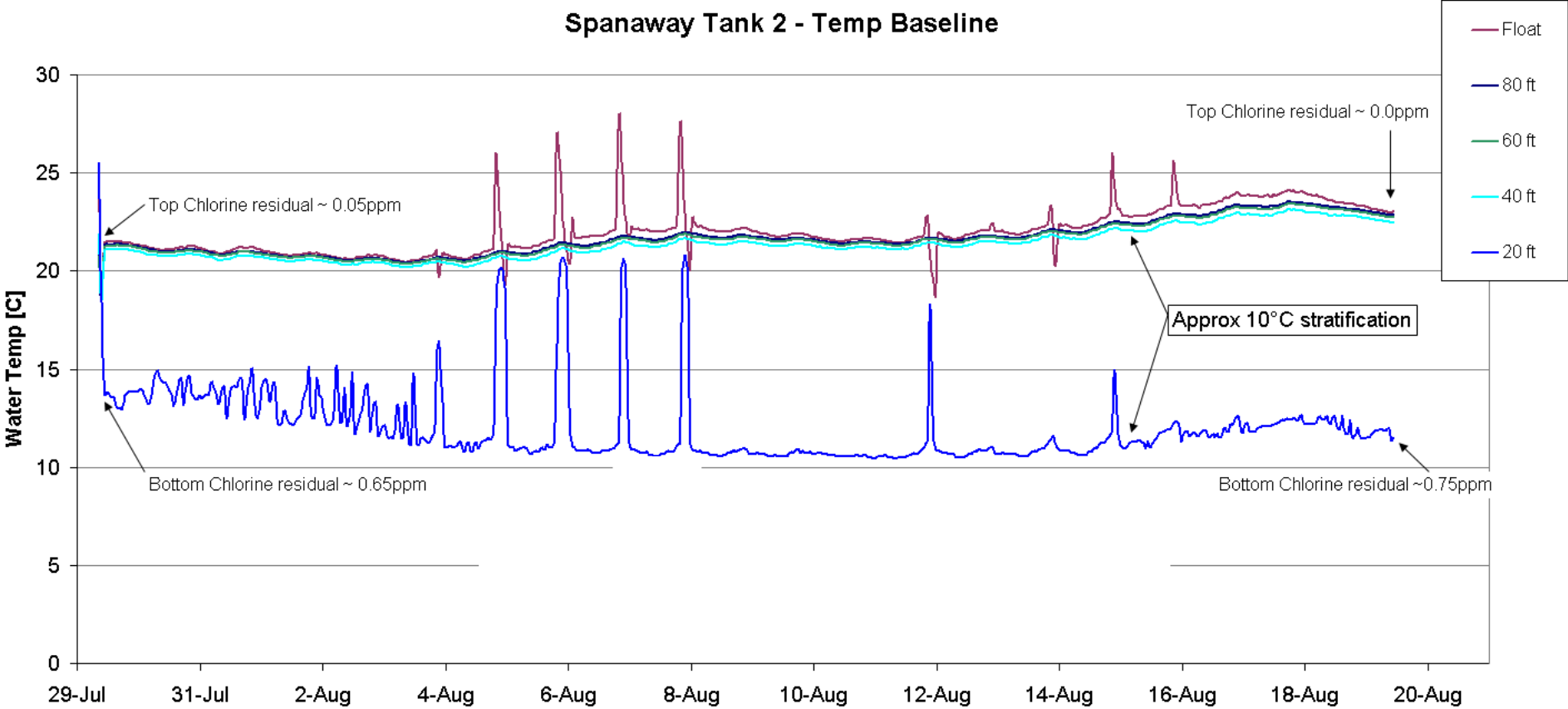
- Only 20 ft string was in cool water





Temperature Results

Spanaway Tank 2 - Temp Baseline



CFD Analysis

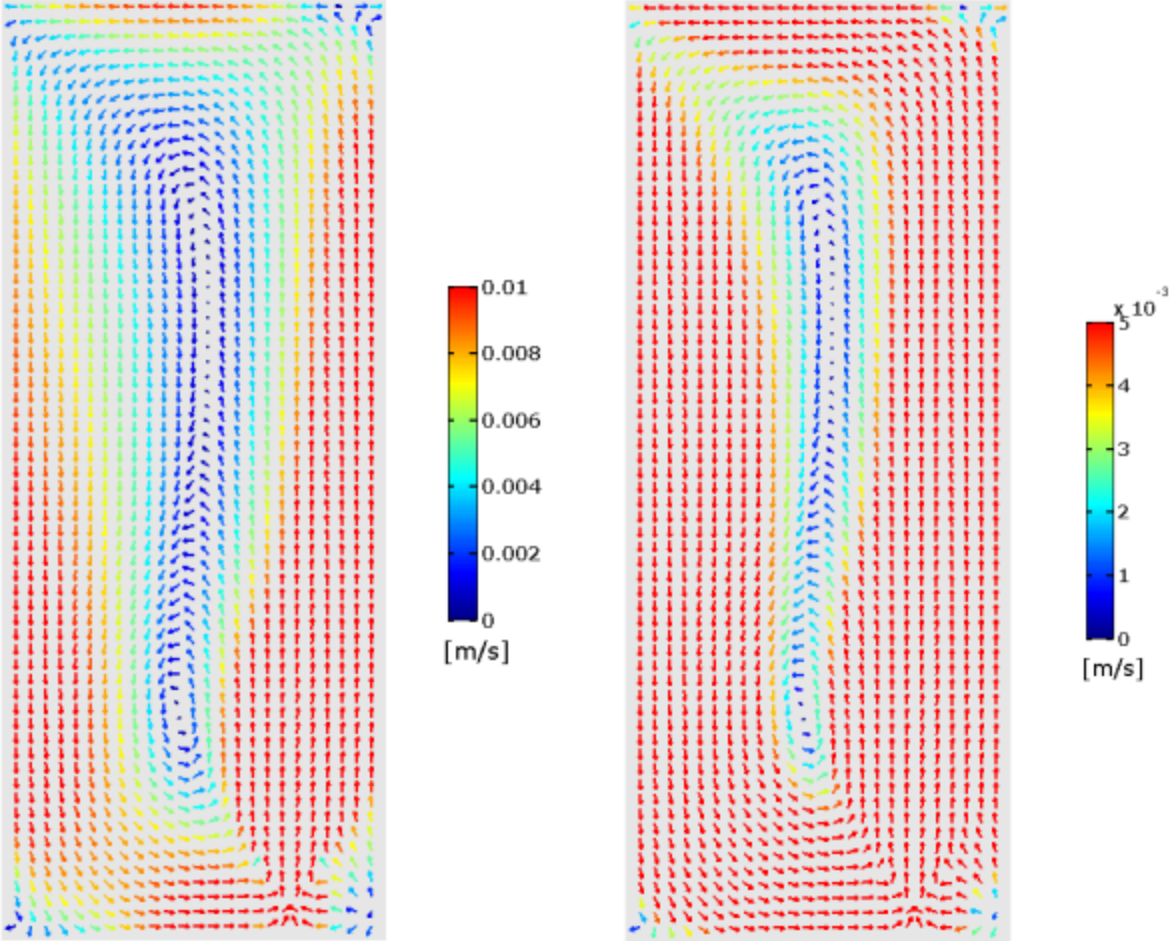
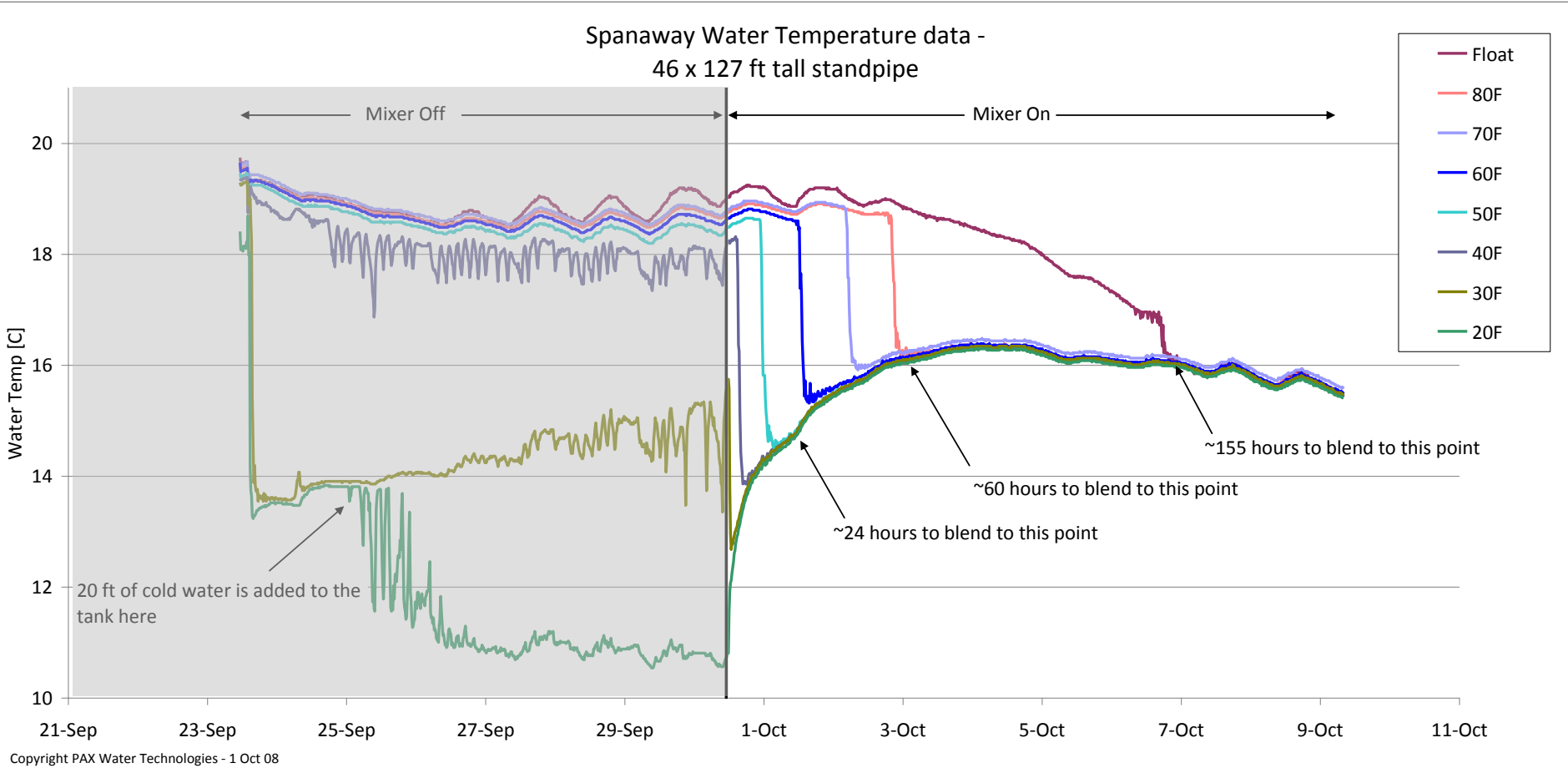


Figure 2: Velocity vectors and magnitude (m/s). Side view of a cross-section in the middle of the tank.

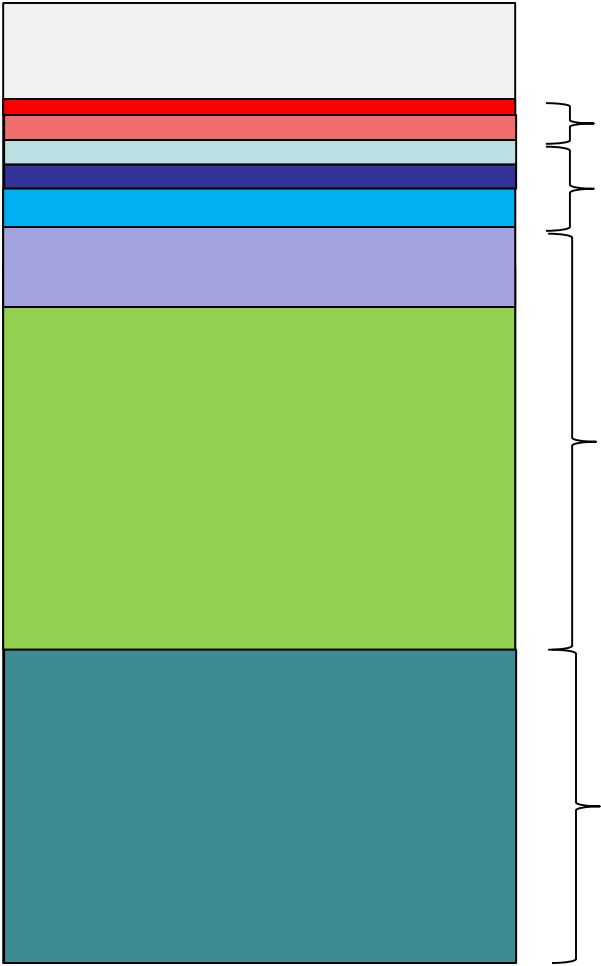
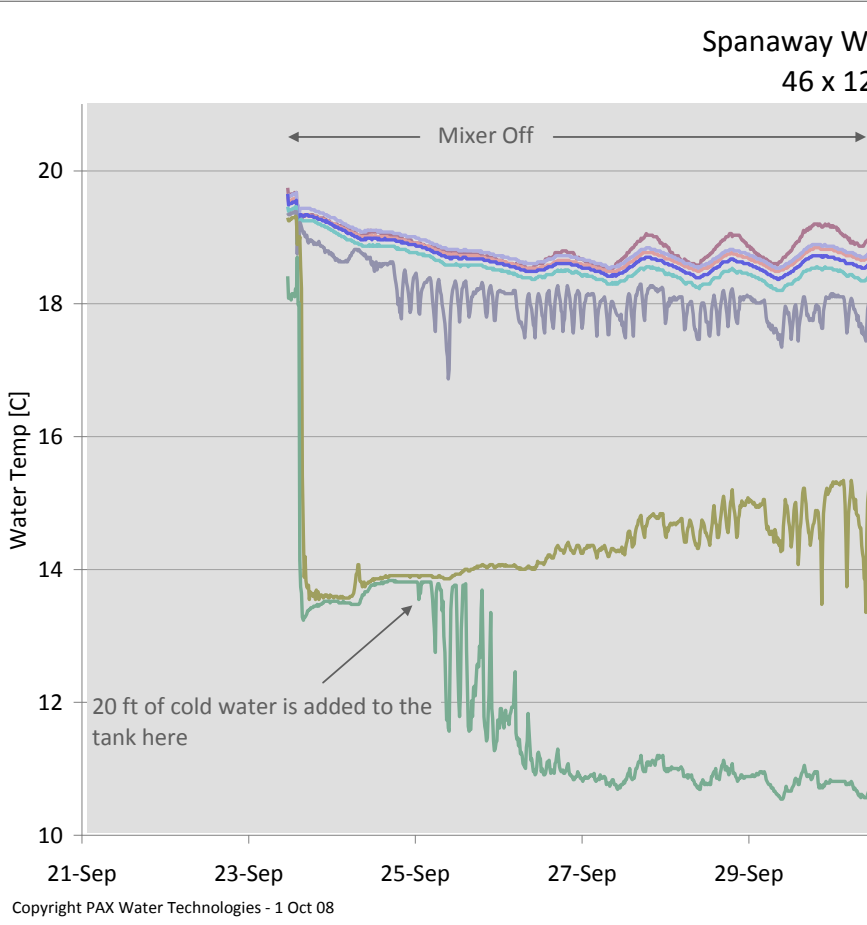


Standpipe 46' x 127' 1.5MG

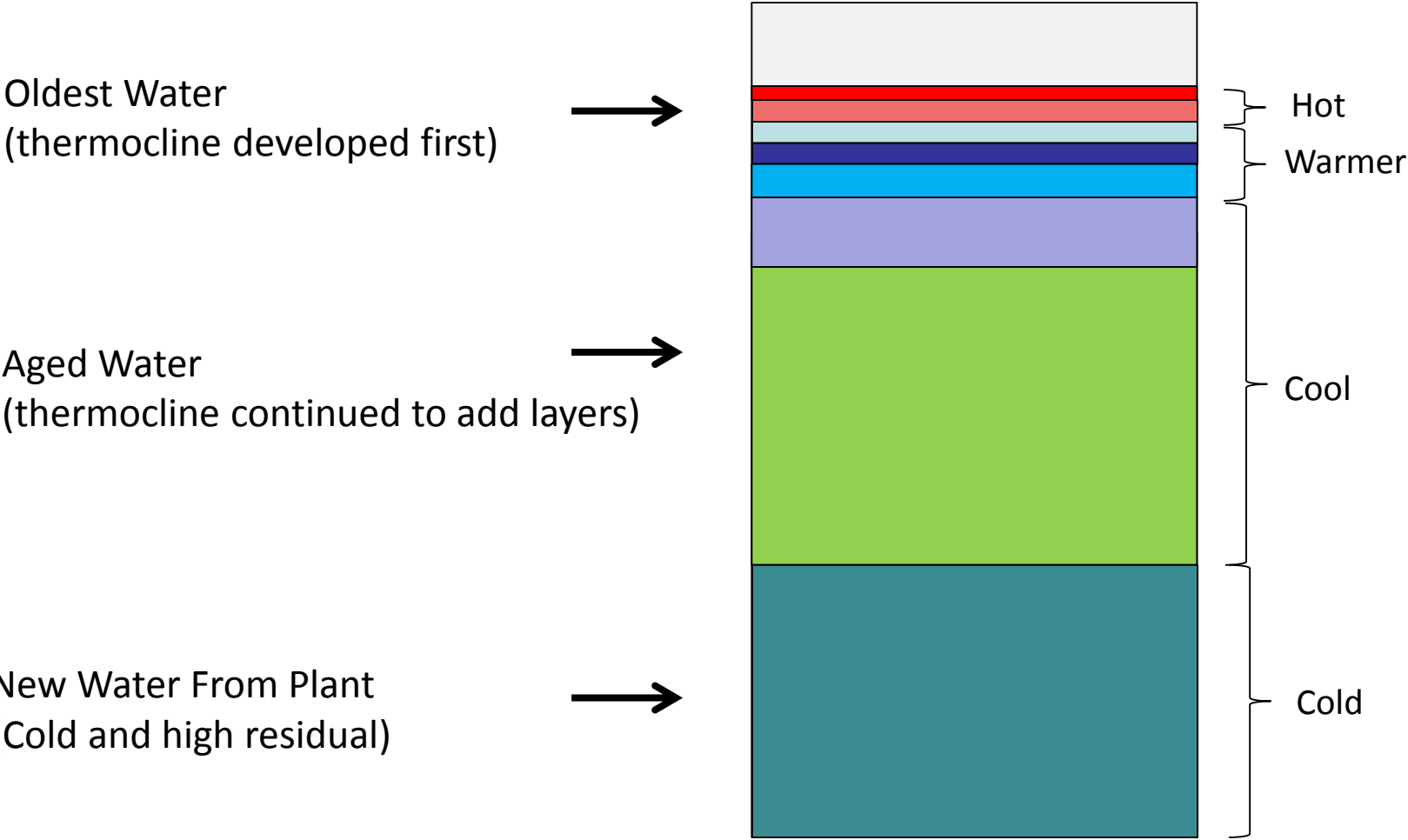
Spanaway Water Temperature data -
46 x 127 ft tall standpipe



Stratification Layers Explained



Stratification Layers Explained



Stratification Layers Explained

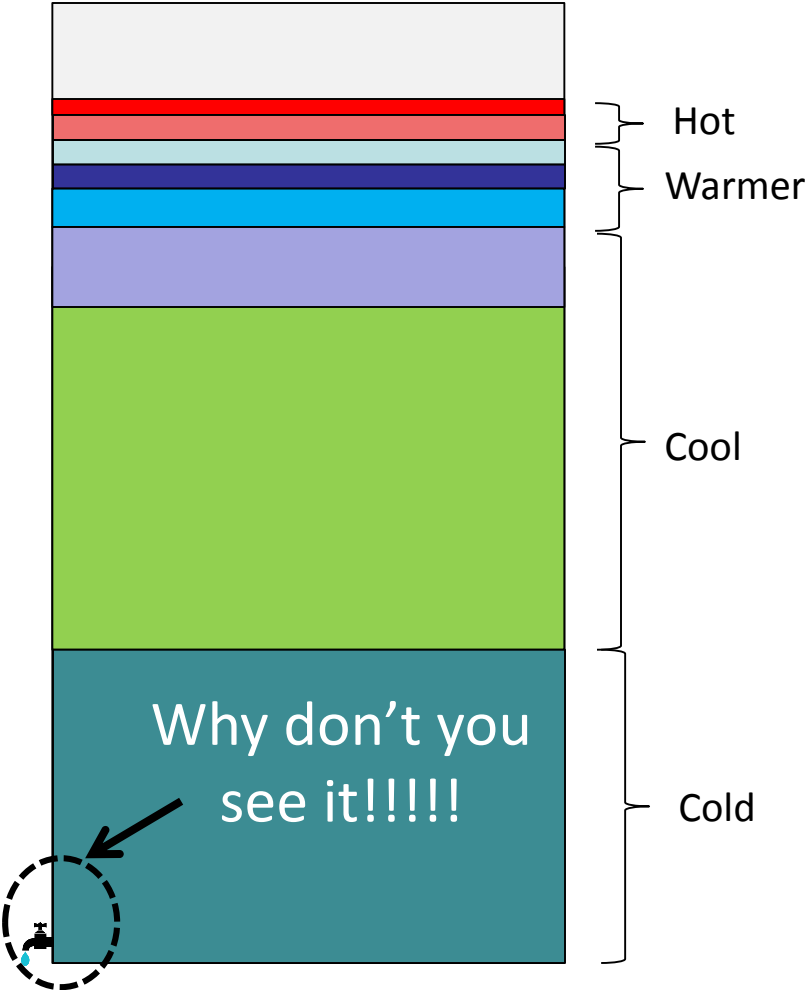
Oldest Water
(thermocline developed first)



Aged Water
(thermocline continued to add layers)



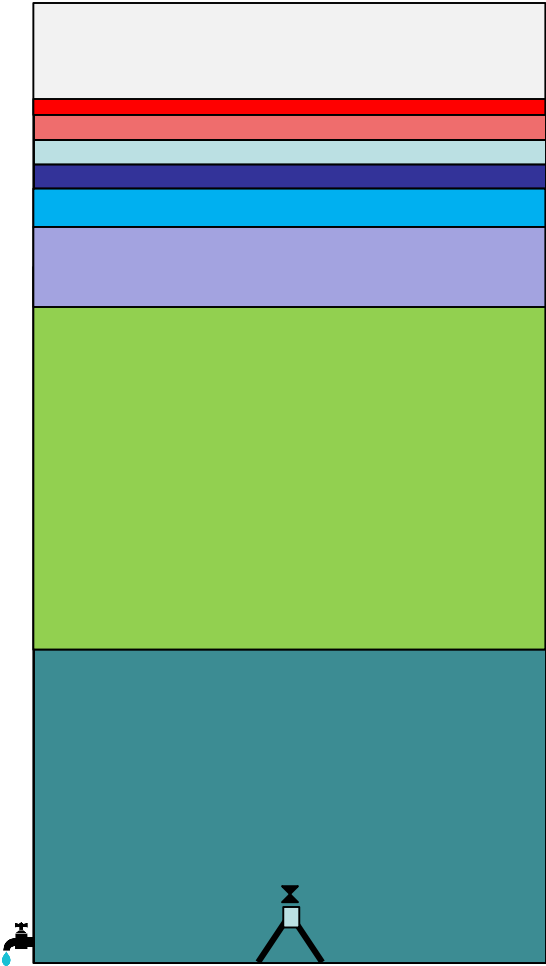
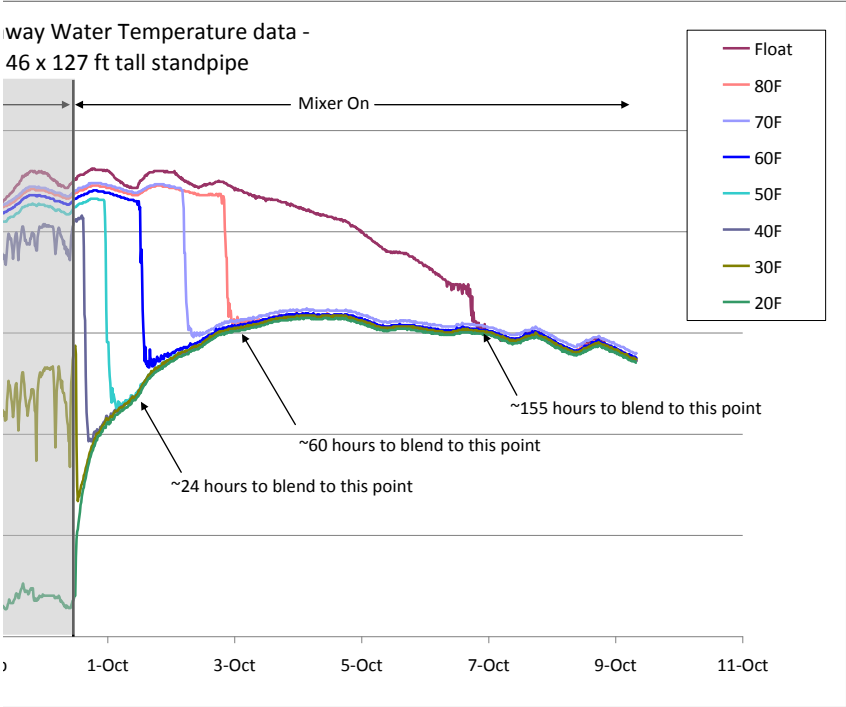
New Water From Plant
(Cold and high residual)



Why don't you see it!!!!

Why Pumping Rate??????

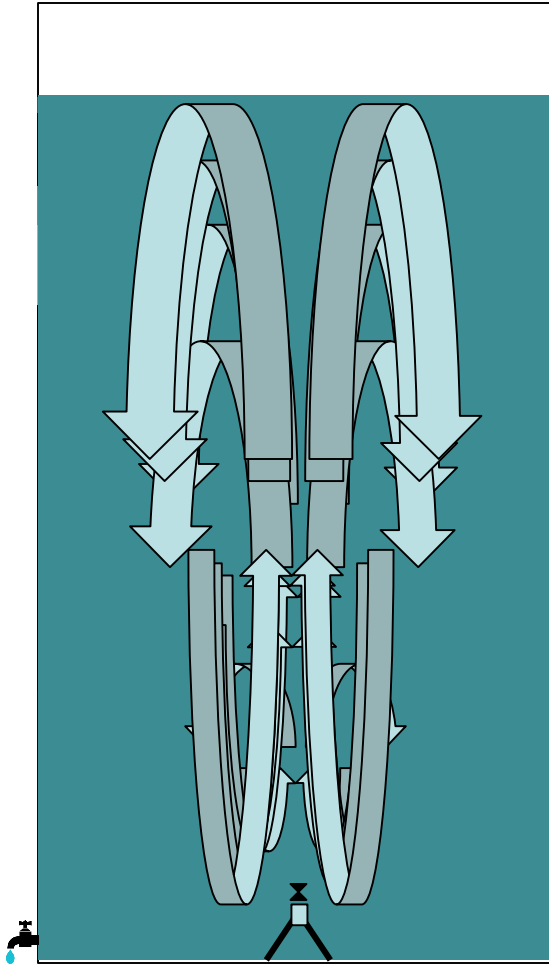
Even with high velocity and output (10k GPM)... 155 hrs to blend!



Why Pumping Rate??????

Even with high velocity and output (10k GPM)

You must homogenize one layer at a time...



Why Pumping Rate??????

Even with high velocity and output (10k GPM)

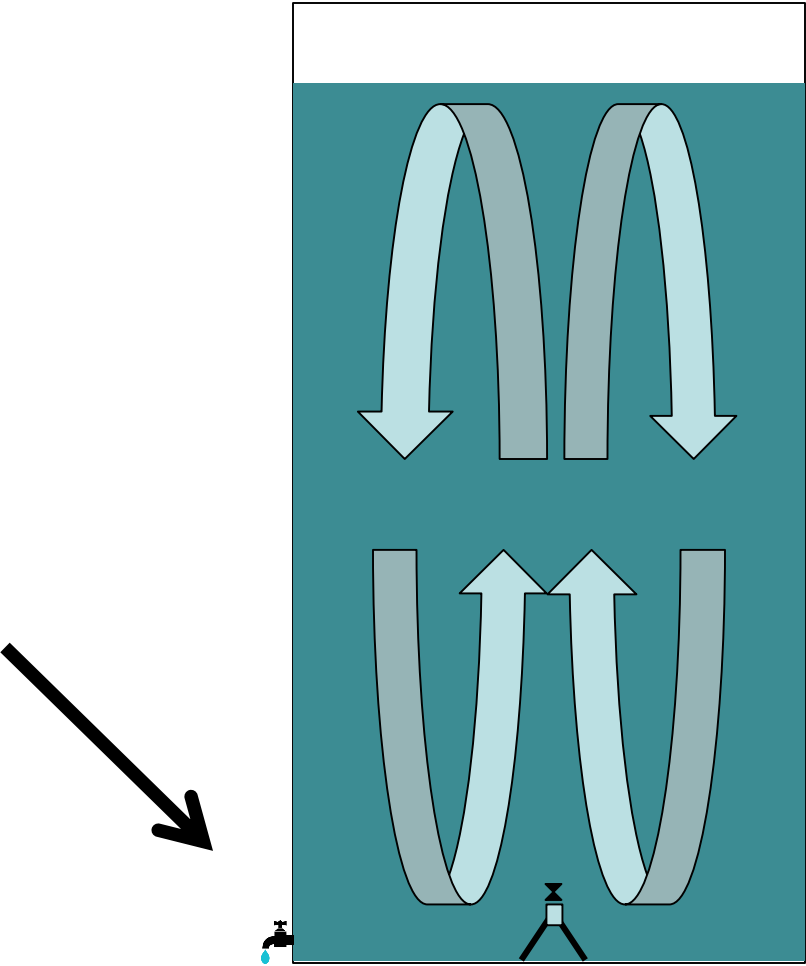
You must homogenize one layer at a time...

Weak mixers can't keep up with thermal loading or reach the top!



Why Pumping Rate??????

Once Mixed...Now you
have a representative
sample you can trust!





De-icing study at Old Town, ME

**“Coldest Winter on Record”
Dec 2008 - March 2009**

Sweat line on both tanks



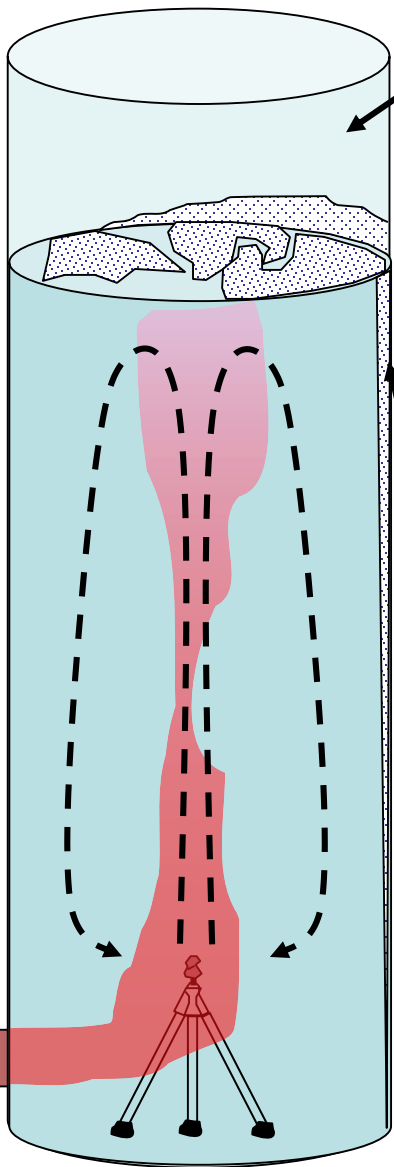
Tank 1



Tank 2



South North



Warmer headspace

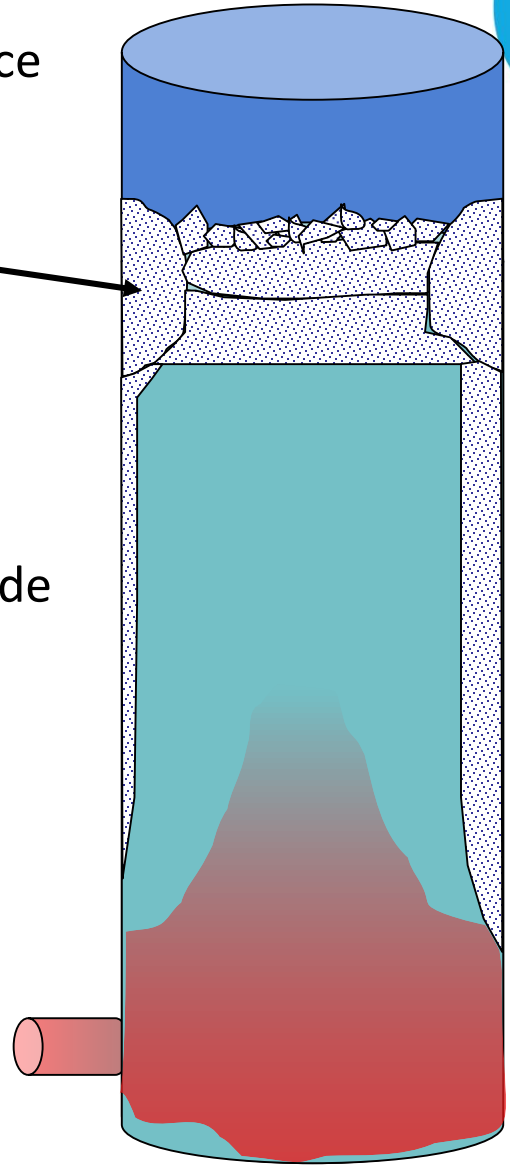
Thicker ice ring and lots of scraping

Thinner ice on N side

42°F

Tank 1 (mixer)

South North

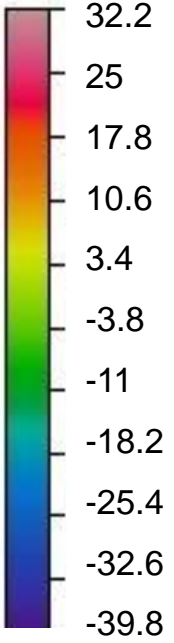


Tank 2 (no mixer)

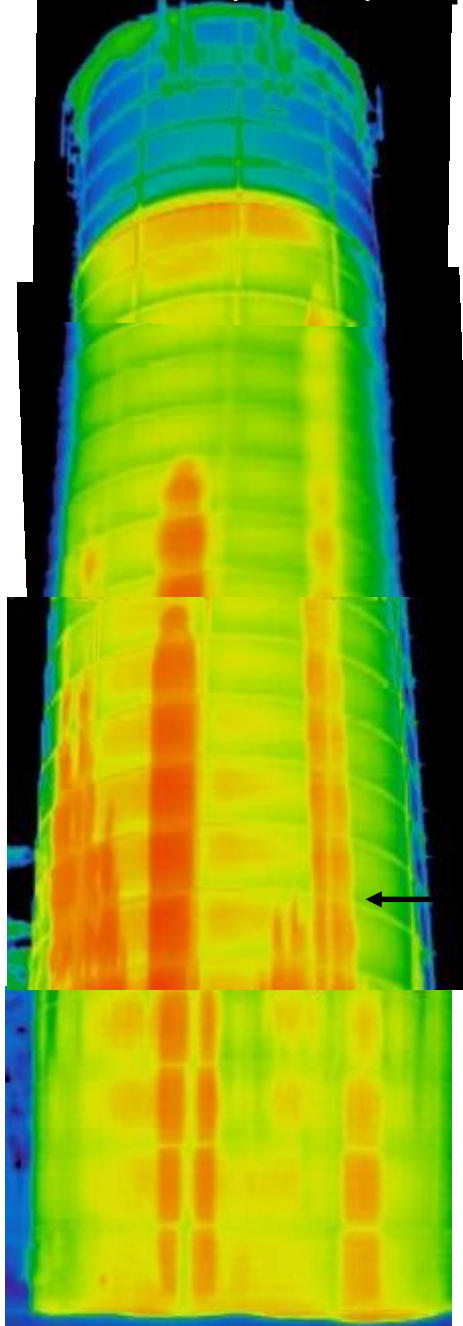
Tank 1 (mixer)

Tank Skin Temperature

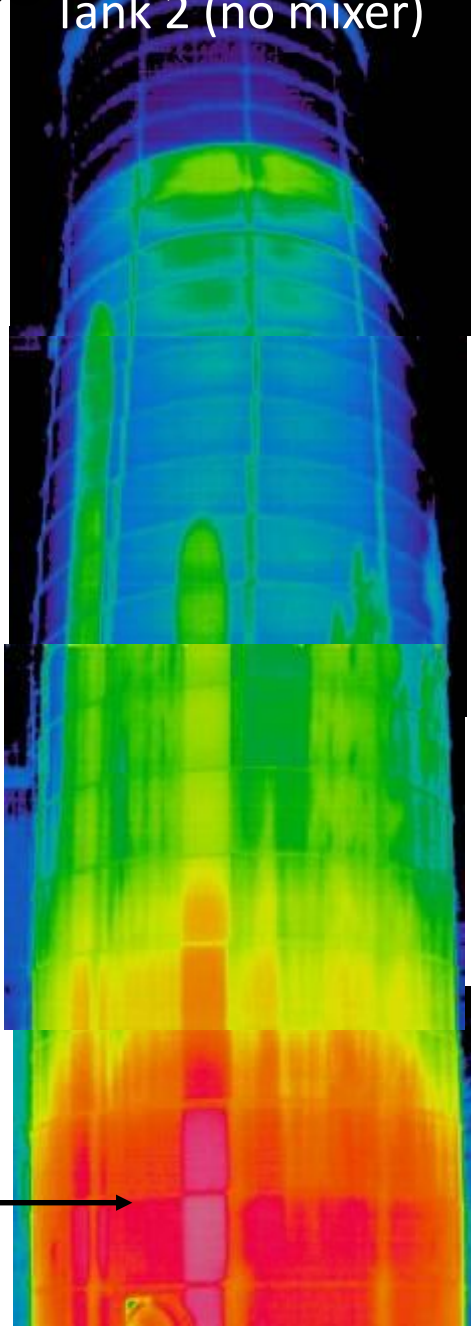
Tank 2 (no mixer)



F



Evenly mixed/
homogeneous water
all the way up to top
of tank
(PAX Mixer)

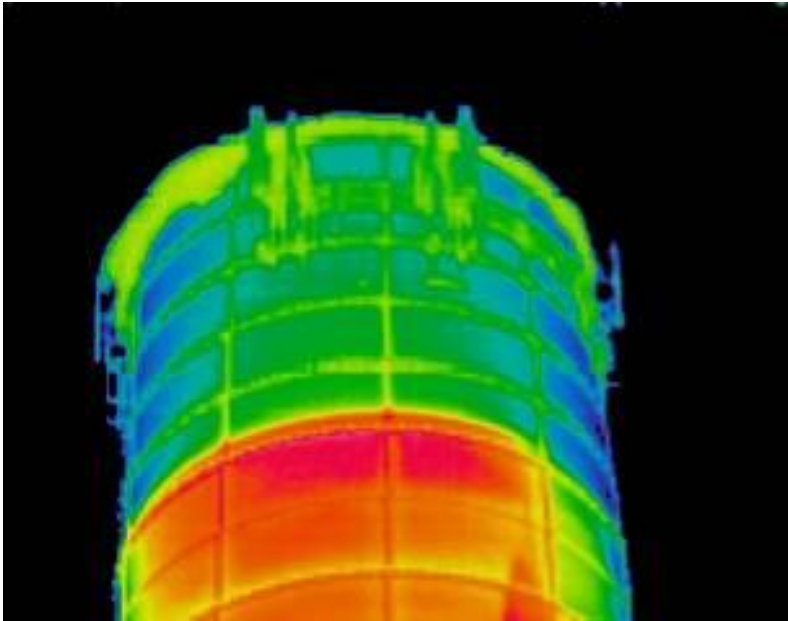


Pocket of warm water
at tank bottom
(no mixer)



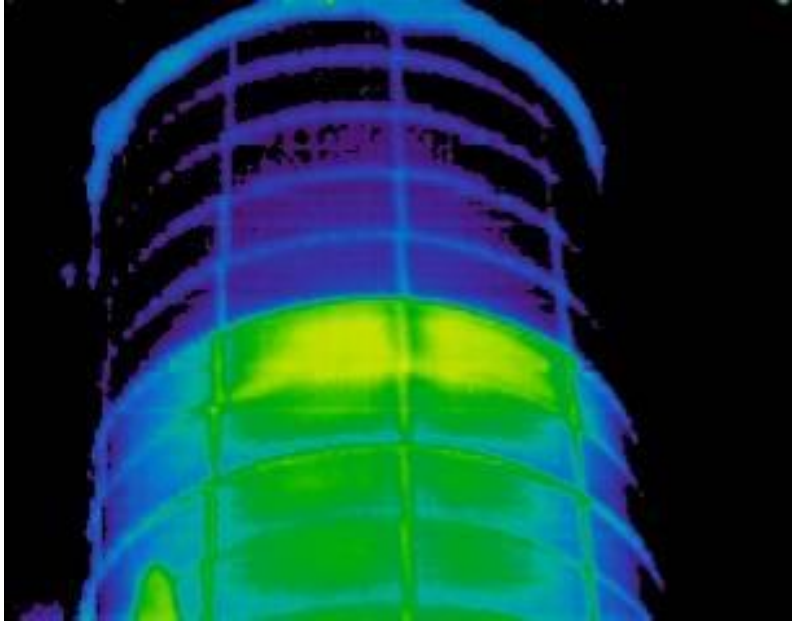
IR images of Tank tops

Headspace temp ~ 0F
(much warmer than outside air)

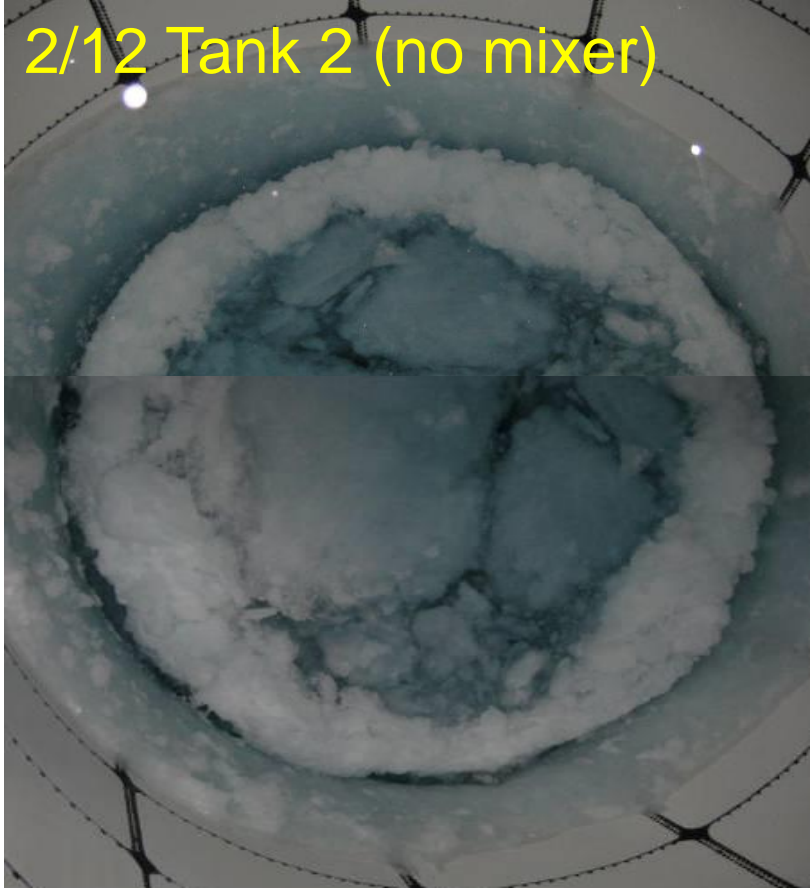


Tank 1 (mixer)

Headspace temp < -40F
(same as outside air temp)



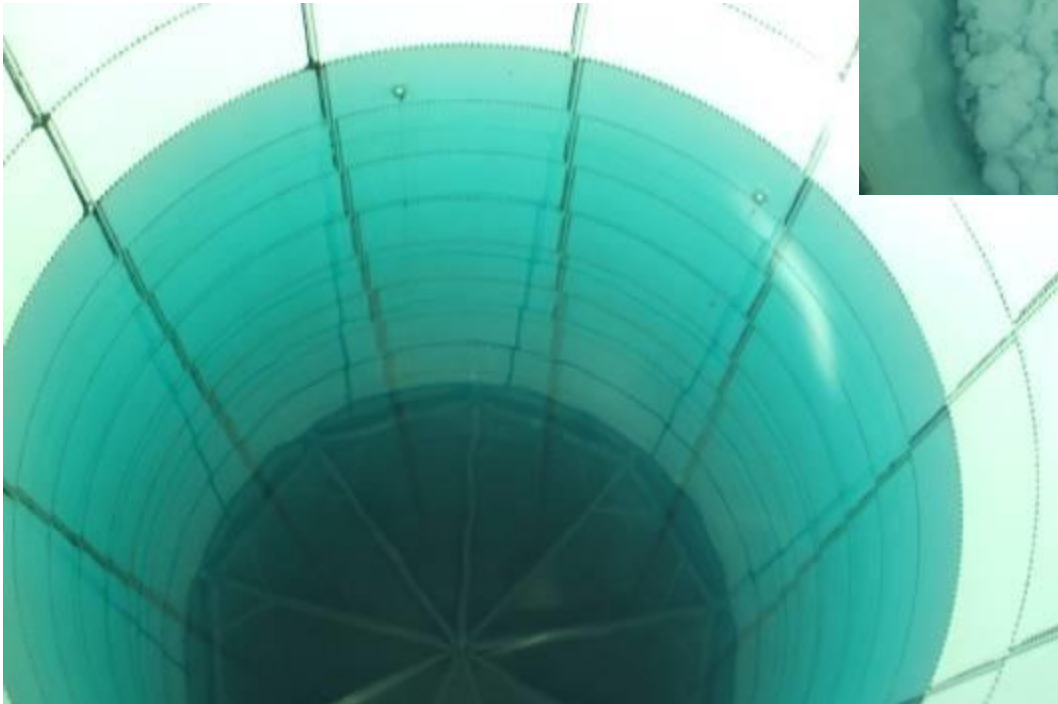
Tank 2 (no mixer)



- 40F.... No damage to tank. Its all about GPM!

Spring Thaw – 3/25

Tank #1 – Mixed



Tank #2 – not mixed

Case Study: Laramie, WY

- 300,000 gallon pedisphere
- Severe ice problems in winter
- Low residual levels in summer





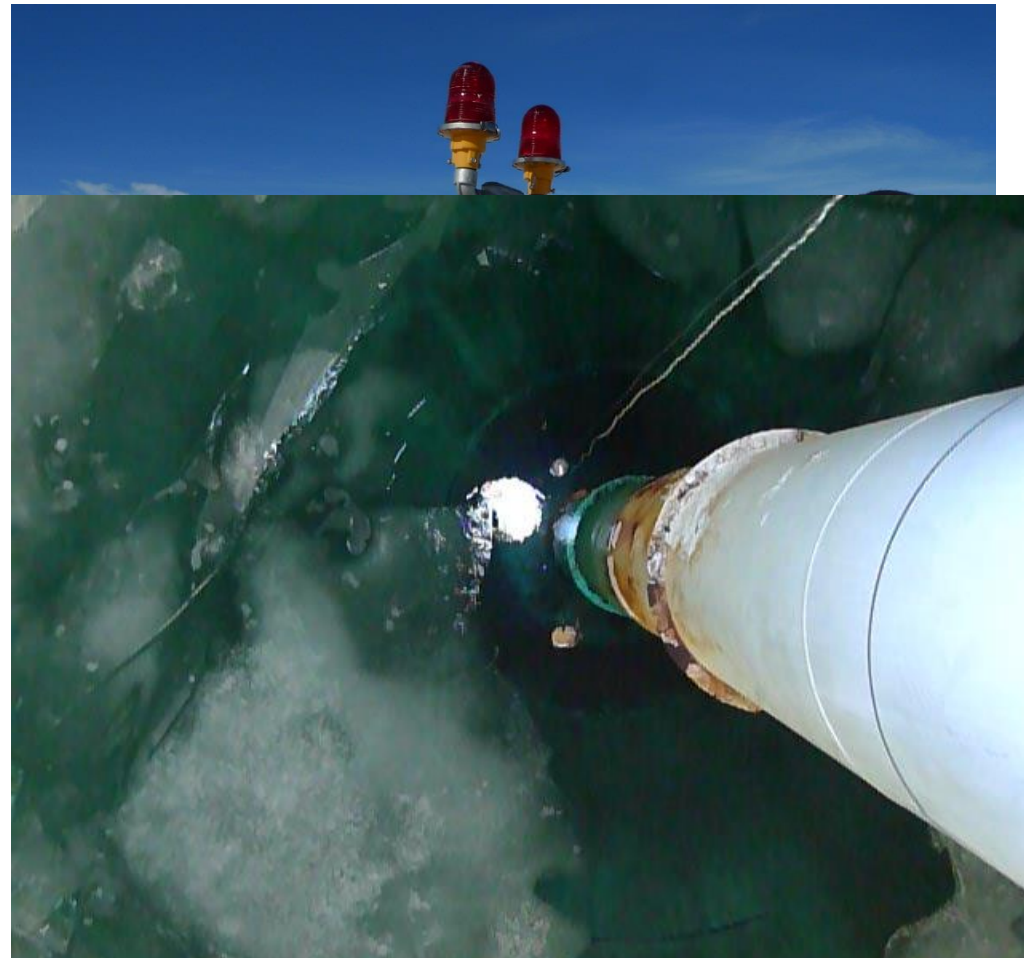
Produces powerful vortex jet: like rifling of a bullet



Jet mixer can mix up to 750,000 gallons

Mixer to the rescue

- Powered mixer from obstruction light circuit
- Installed mixer into tank w/ temp string



Day 0



24 hours later



1 week later: ice free

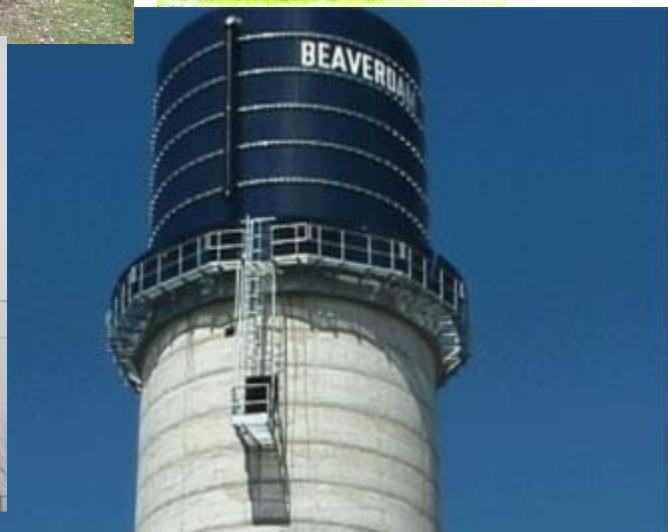
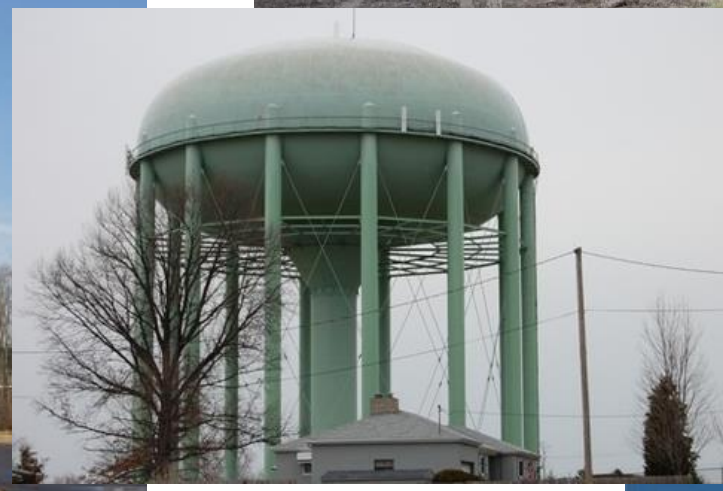
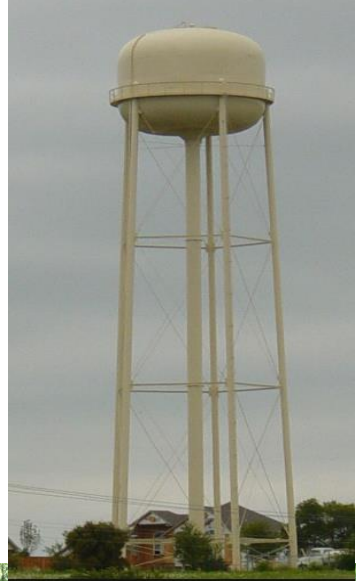
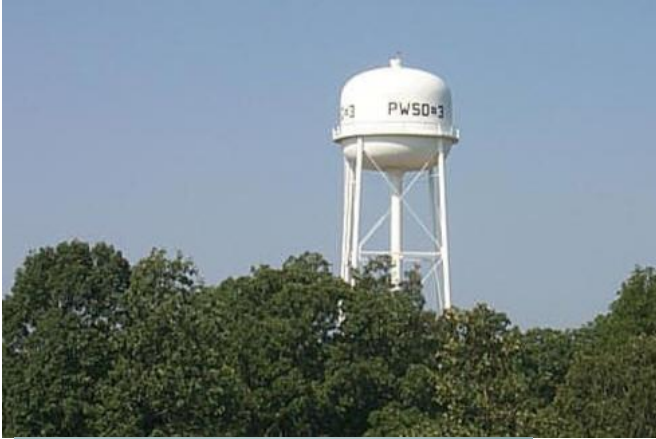


How much mixing do I need to keep my tank ice-free?

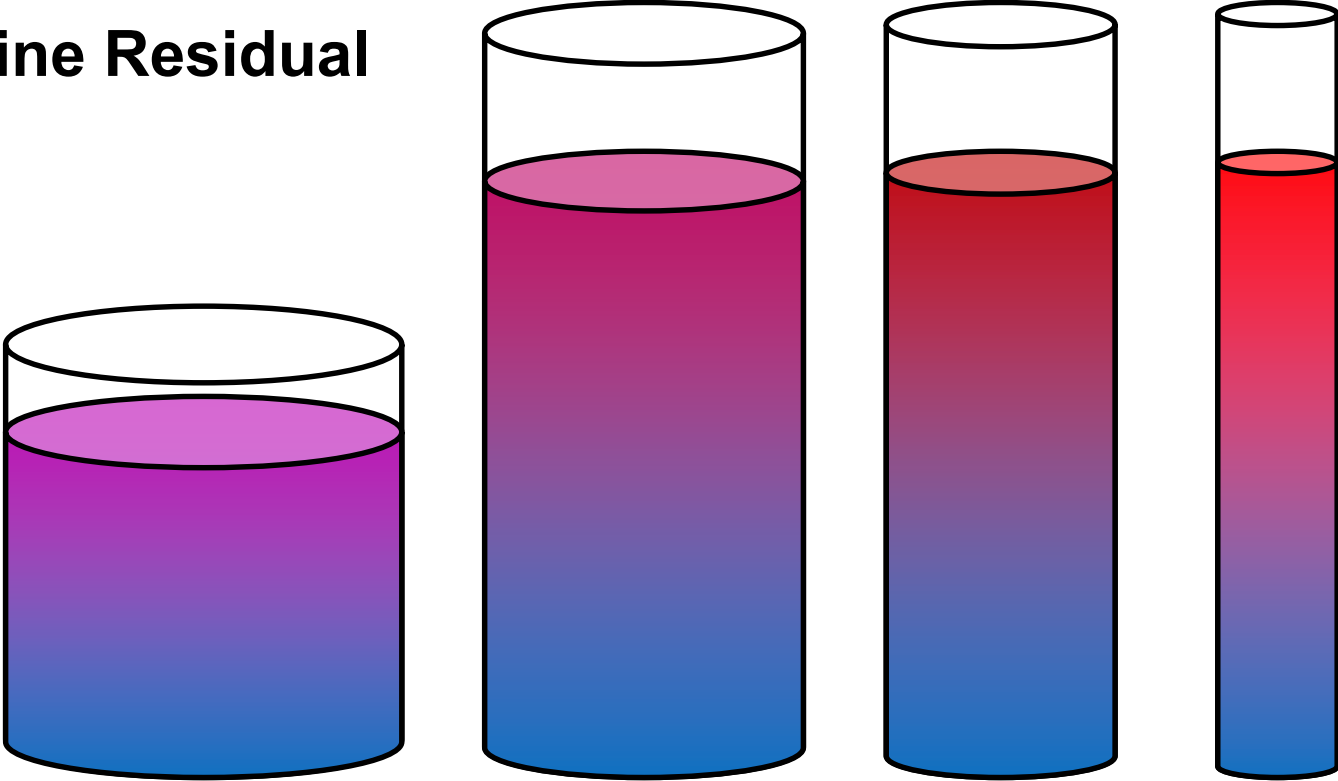
- Depends on the size and shape of the tank
- Depends on the temperature (and sunlight)
- Depends on turn-over
- Depends on the inlet water temperature
- Depends on color of tank
- Depends on tank's R-value (steel, concrete, glass, etc)



How to choose the correct mixer?



- Aspect Ratio of the tank (height vs width)
- Tank Turnover (Blend time)
- Geometry of tank (Square, rectangle, round)
- Surface water vs ground water
- Ice Conditions
- Chlorine Residual



Higher surface area-to-volume ratio





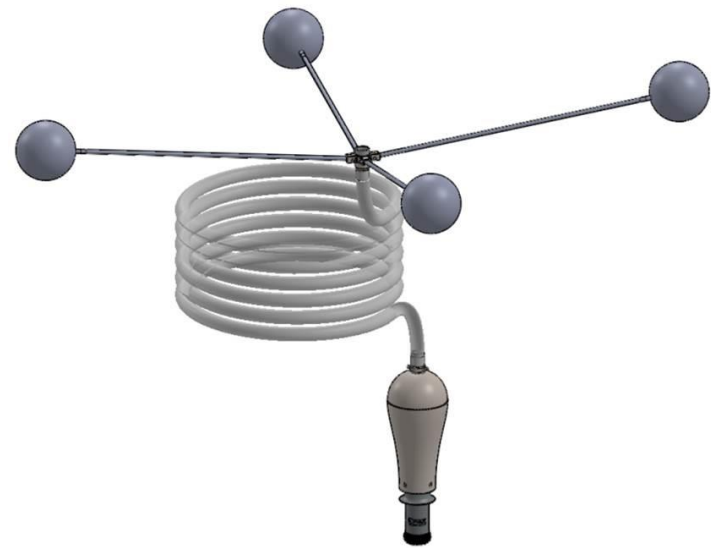
1st active mixer was
launched in 2005

750 KG to 25 MG



Next generation
was designed for
large, short, wide
tanks

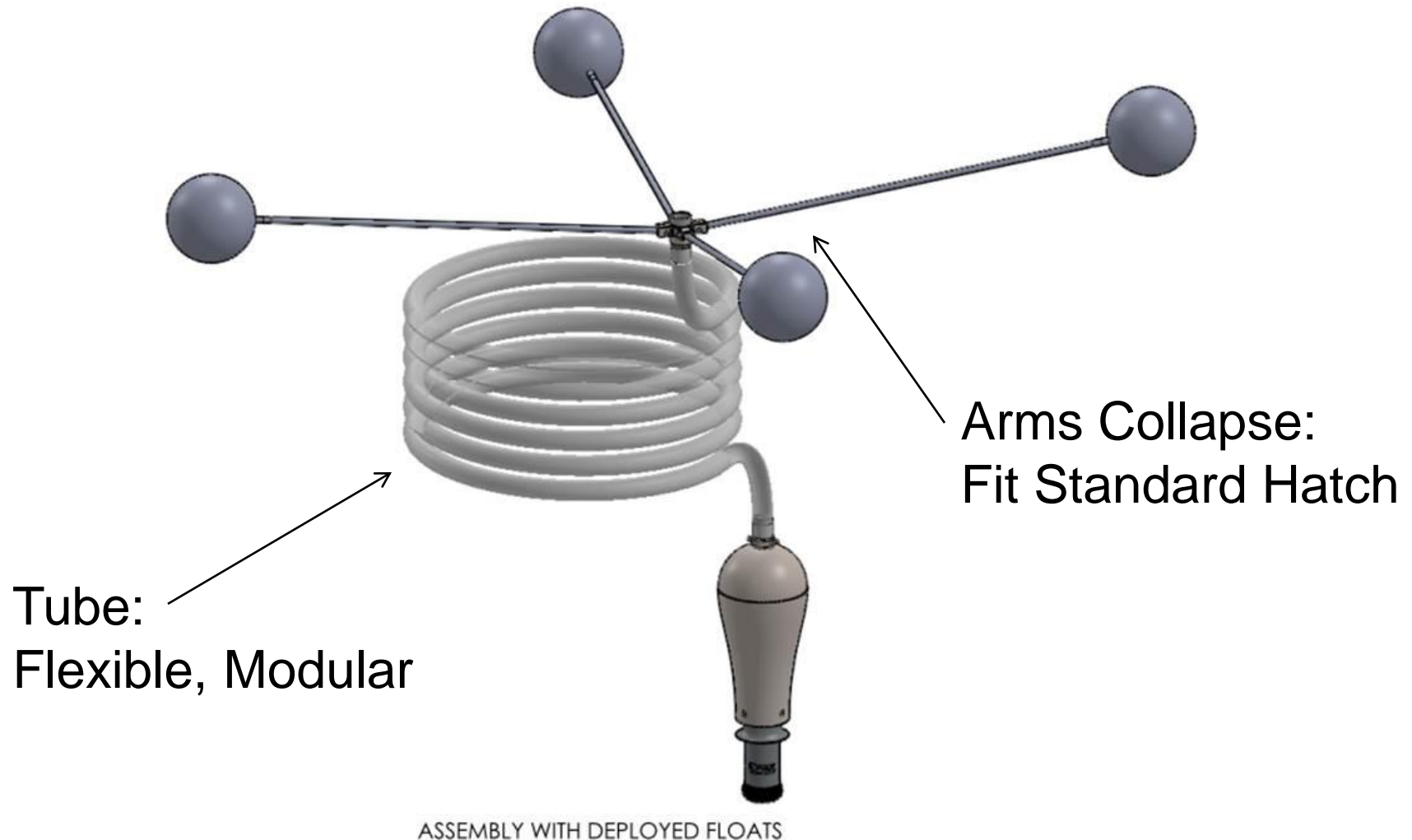




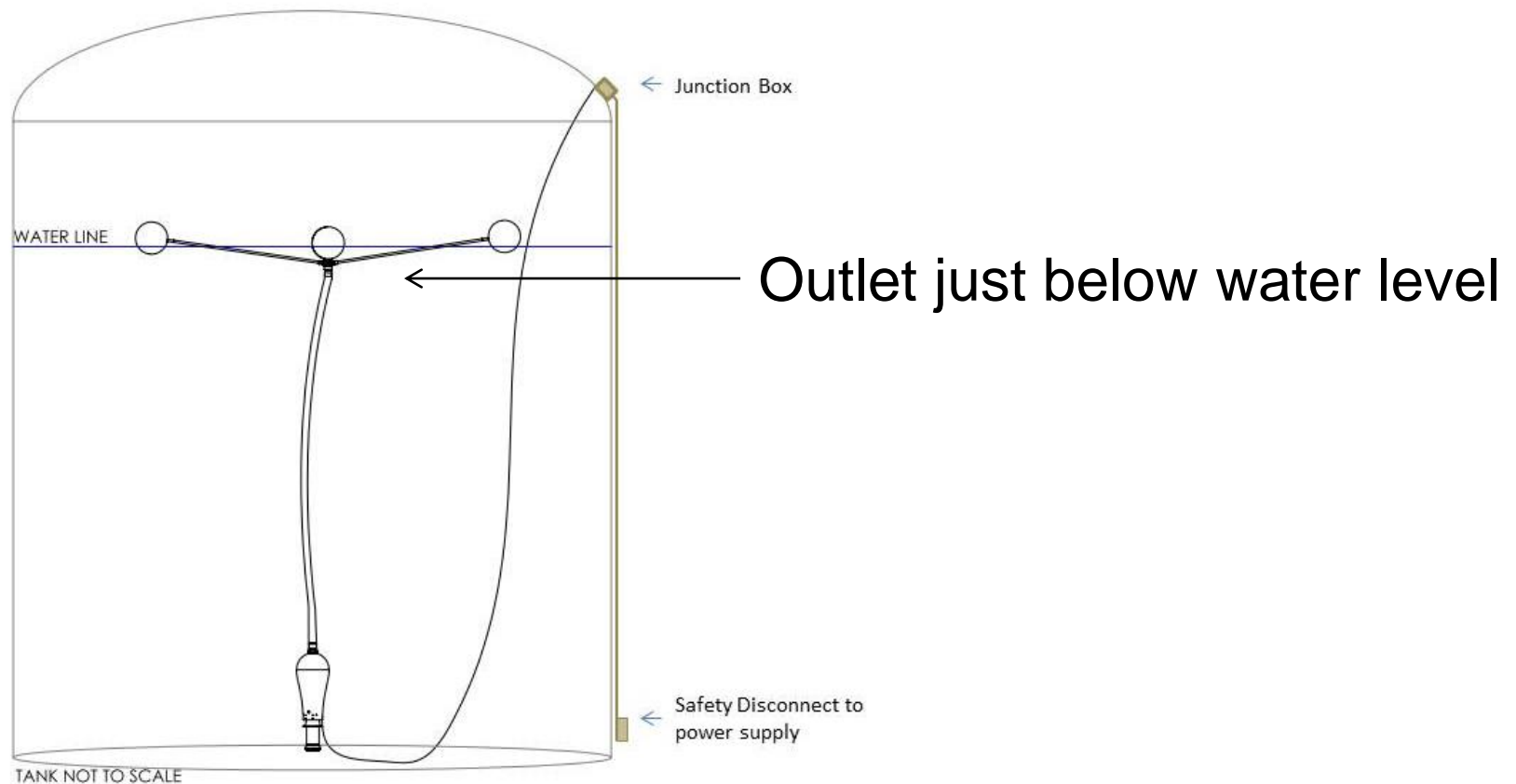
ASSEMBLY WITH DEPLOYED FLOATS



Moving Forward – New Design – Installed Wet!



Moving Forward – New Design



PAX Water Mixer Family – for All Types of Tanks

PWM100 / PWM150

Compact, lightweight jet mixer. Utilizes PAX's patented vortex nozzle design for powerful mixing in small to mid-size tanks.

TANK SIZE:

Up to 375,000 gal (PWM100)
Up to 750,000 gal (PWM150)

TECHNICAL DATA:

Power Supply: 120 VAC
Power Draw: 670 watts
Height: 30" (PWM100)
34" (PWM150)
Weight: 40 lbs (PWM100)
42 lbs (PWM150)

FEATURES:

- Self-install design
- Points upward, even on sloped floor
- Completely NSF-61 certified

OPTIONS:

- Chemical feed attachment
- SCADA-compatible



PWM200 / PWM400 / PWM500 / PWM600

Powerful tripod-mounted mixer using PAX's patented Lily impeller to create power and energy efficiency

TANK SIZE:

Up to 0.75 MG (PWM200)
Up to 9 MG (PWM400)
Up to 15 MG (PWM500)
Up to 25 MG (PWM600)

TECHNICAL DATA:

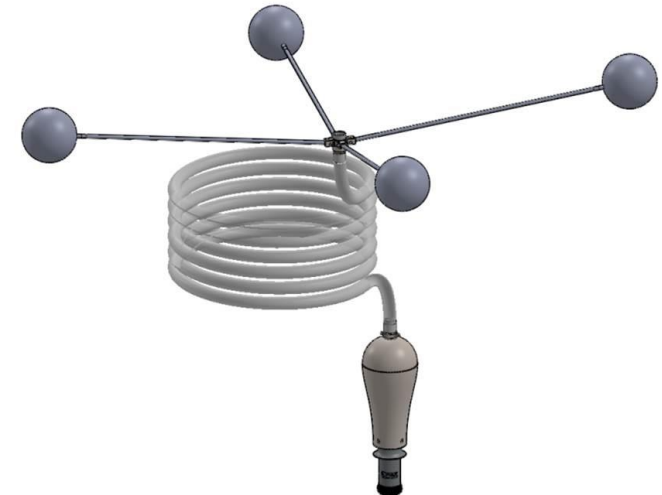
Power supply: 120/240 VAC
Power draw: 575 watts (PWM200)
345 watts (PWM400)
825 watts (PWM500)
2,130 watts (PWM600)
Height: 38" (PWM200)
49" (PWM400, PWM500, PWM600)
Weight: 47 lbs (PWM200)
53 lbs (PWM400)
59 lbs (PWM500)
71 lbs (PWM600)

FEATURES:

- Fixed or free-standing installation
- SCADA-compatible
- Completely NSF-61 certified

OPTIONS:

- Chemical feed attachment
- Solar powered
- Self-install design



ASSEMBLY WITH DEPLOYED FLOATS

Mixer – CFD for Center position

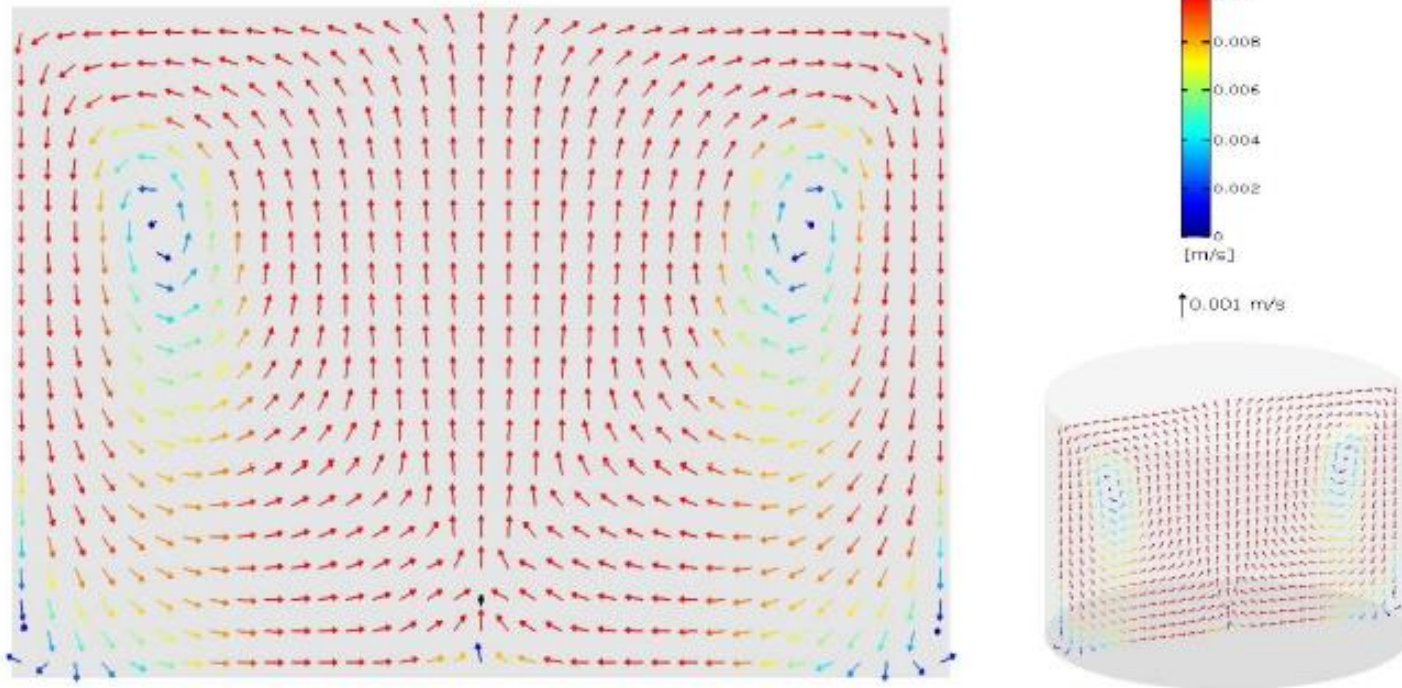
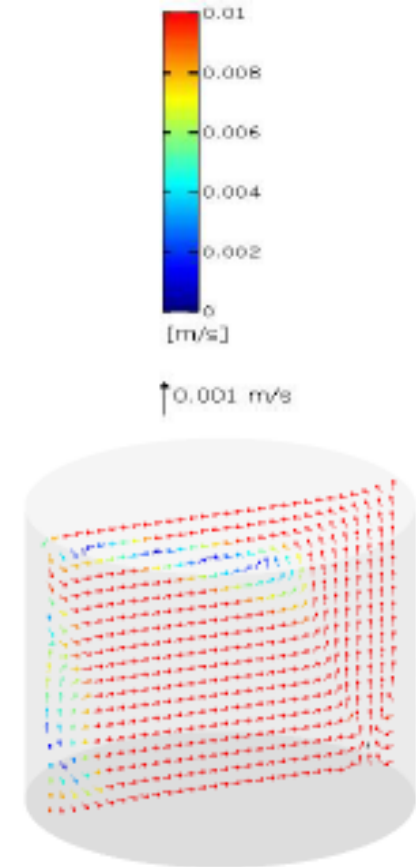
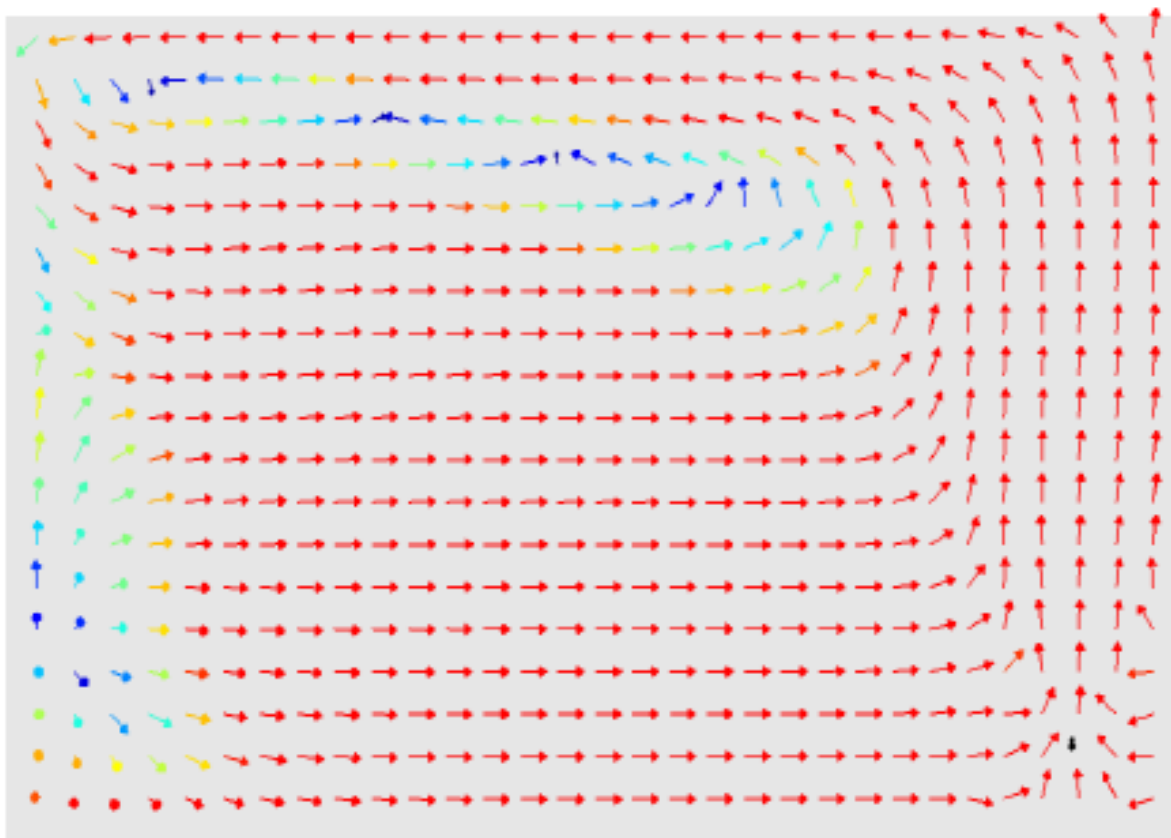


Figure 1. CFD model of a centrally-positioned PAX Water Mixer in 0.5-MG tank (52'x32').

Mixer – CFD for Off-Center position



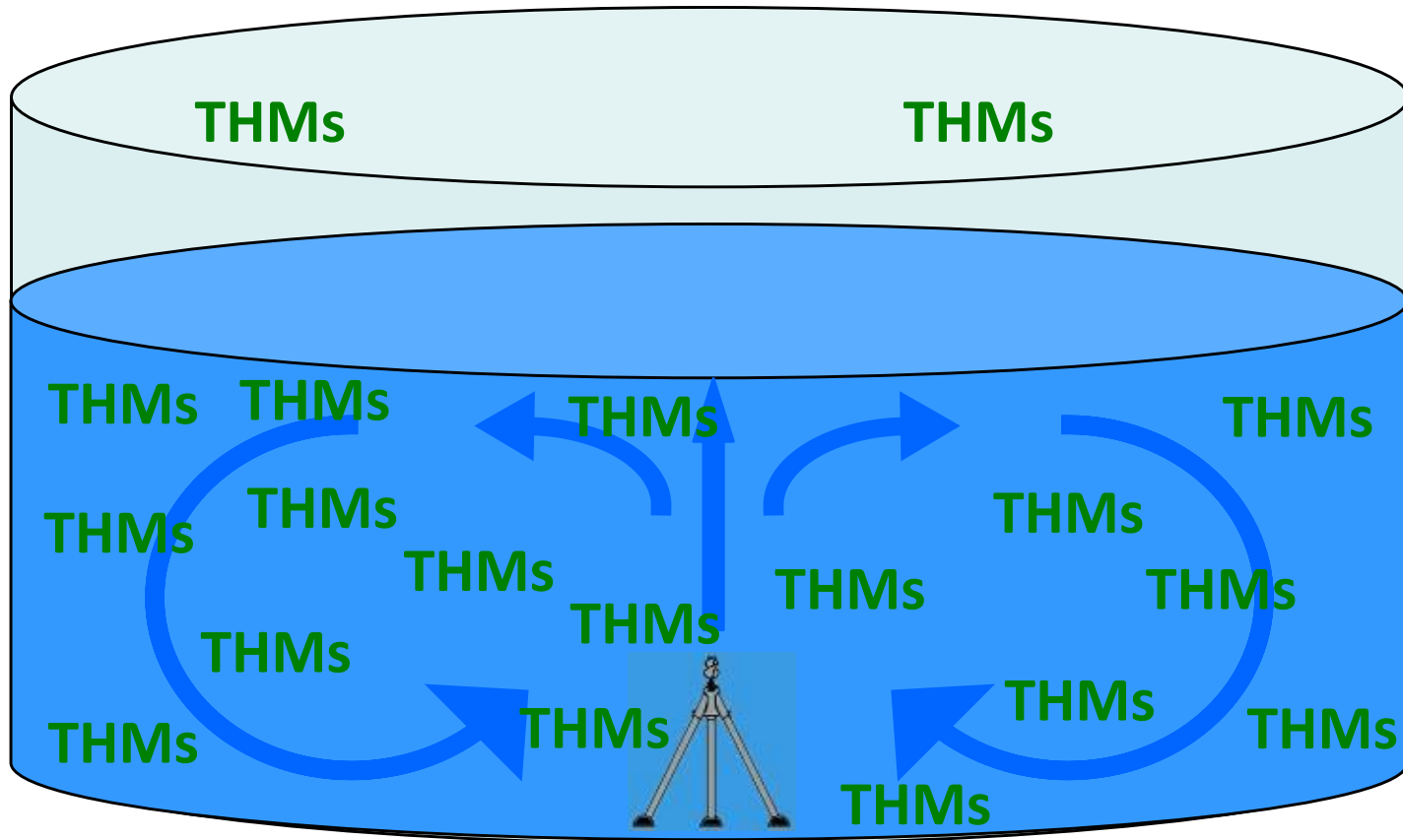
Estimated 10% less efficient

Mixer Control Panel – SCADA

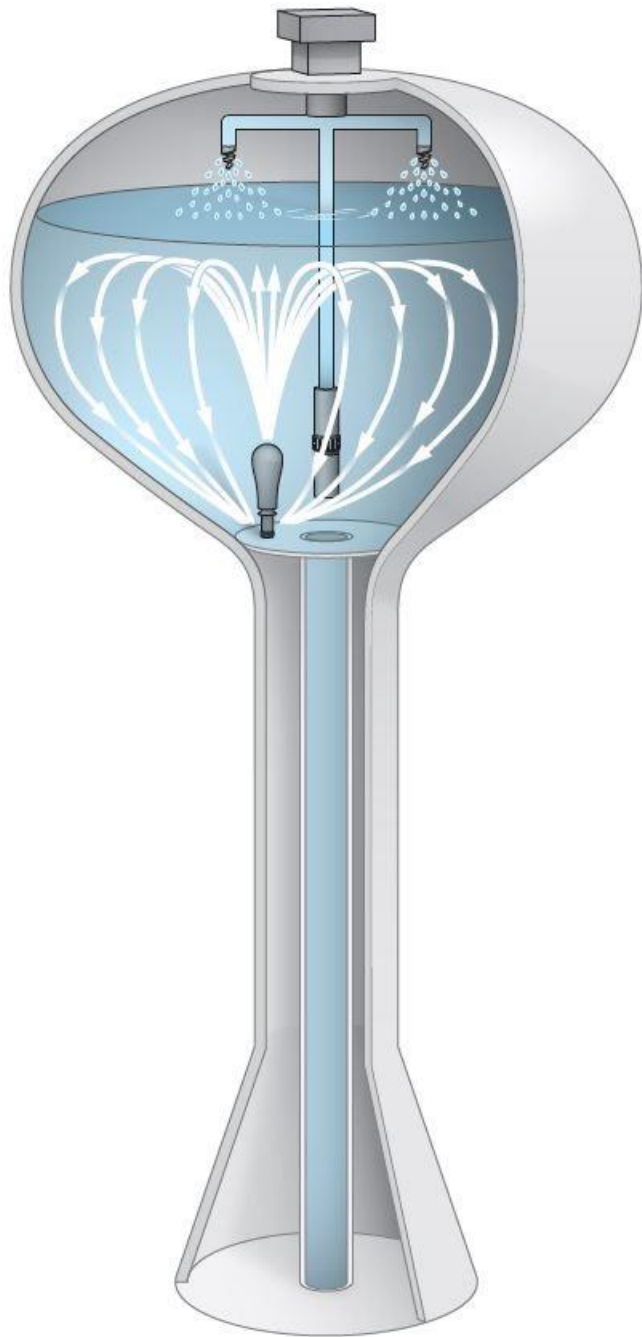


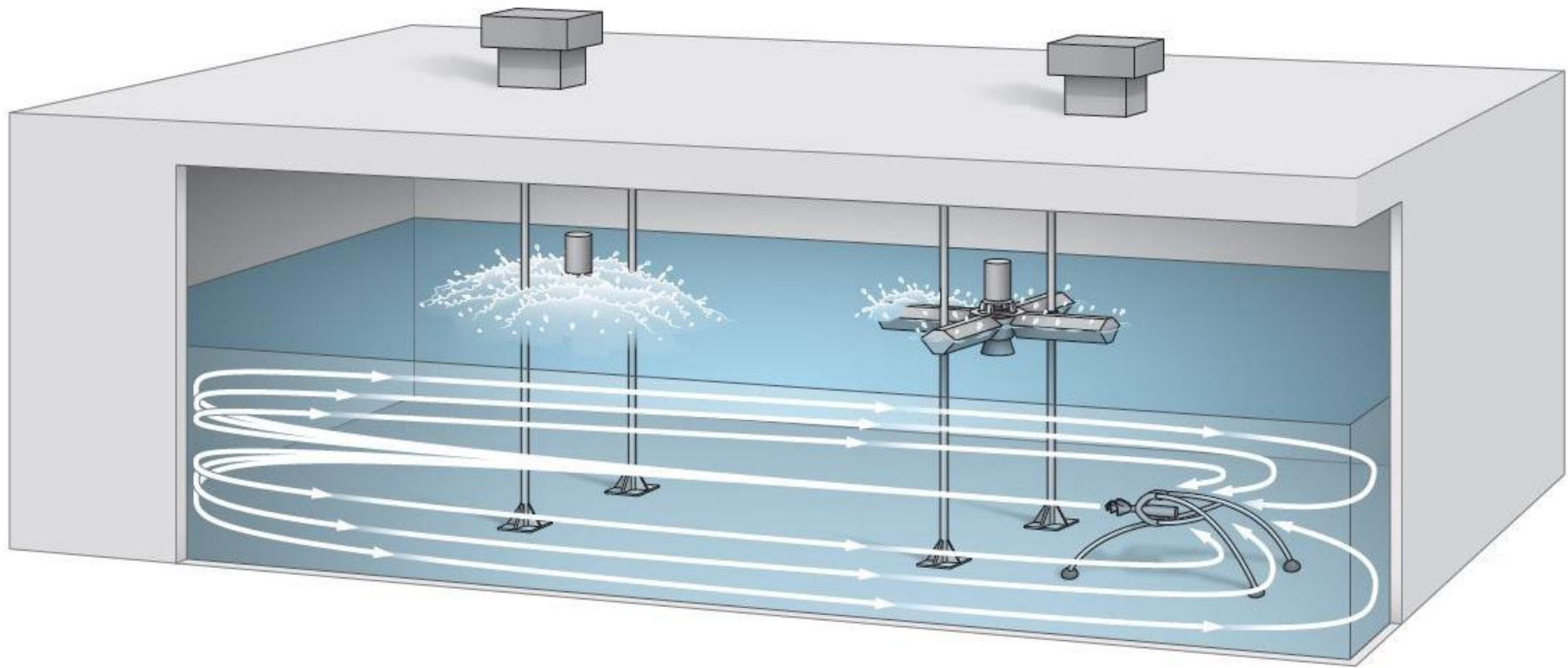
Mixers also aid in THM reduction in tanks.

Mixing enhances aeration



But you need **STRONG** mixing







Questions?

Daryl Bowling
937-765-7827