Tank Mixing Pilot and Full-Scale Case Studies

October 13, 2016

Dr. Peter S. Fiske
PAX Water Technologies, Inc.

 1

Many people contributed to these studies…

- South Coast Water District, CA
- Camarillo Water District, CA
- Old Town Water, ME
- Pinellas County Utilities, FL
- Utility Service Group/SUEZ
- Placer County Water District, CA
- Pittsburgh Water and Sewer Authority, PA
- American Water
- Loudoun County Water Authority, VA

 2

~100,000 drinking water storage tanks in US…

Nearly all of them degrade the quality and consistency of the water they store…

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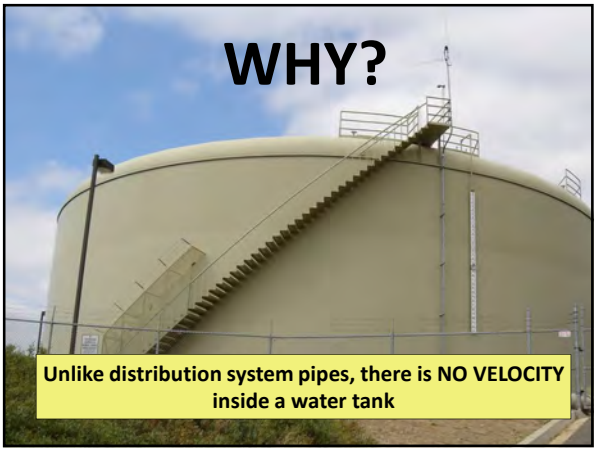


As a result, water storage tanks suffer from…

- Thermal stratification
- Chemical stratification
- Short circuiting
- Elevated water/headspace temperatures
  - Accelerated corrosion
- Disinfectant residual loss
  - Nitrification in chloraminated systems
- Biofilm formation
- Sediment accumulation

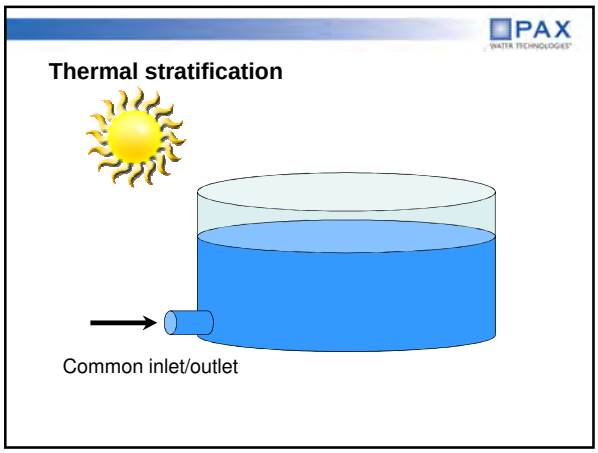
Utilities spend a lot of $ dealing with the consequences of these issues

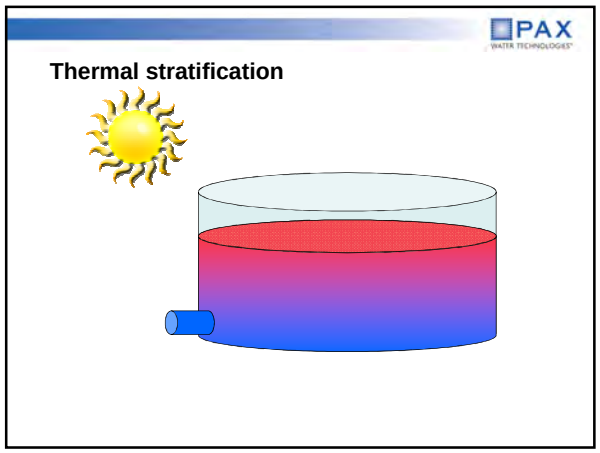
 5

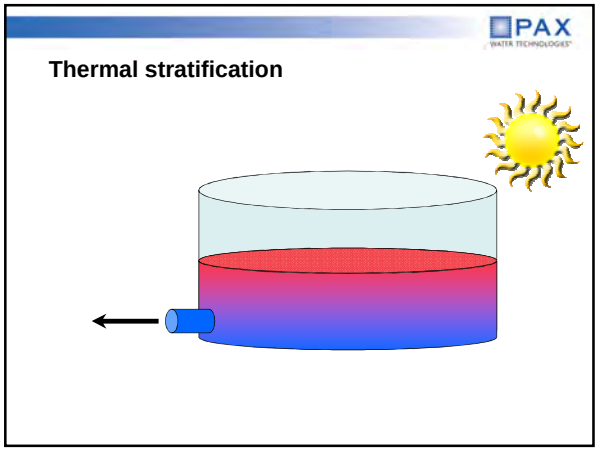
Active Mixing: Tool #1 for Distribution System Water Quality

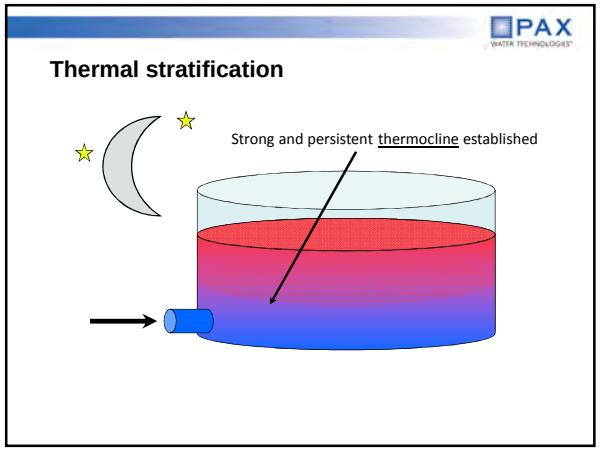
- Eliminates stratification and reduces water age in storage tanks
- Lowers headspace temperatures in tanks in the summer
- Raises headspace temperatures in tanks in the winter
- Reduces residual demand in tanks
- Enables safe, reliable boosting of tanks
- (With active ventilation) can lower THM levels

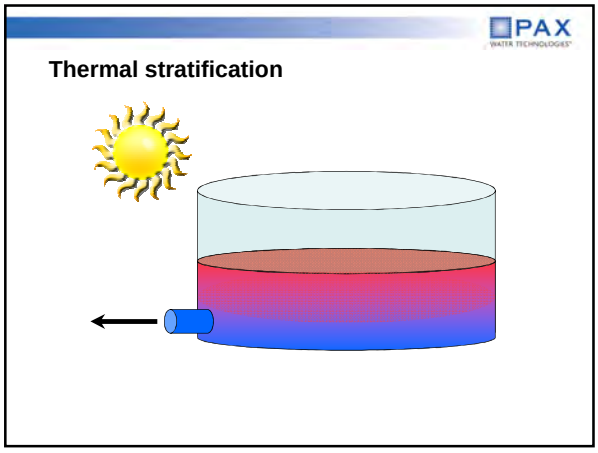
 6

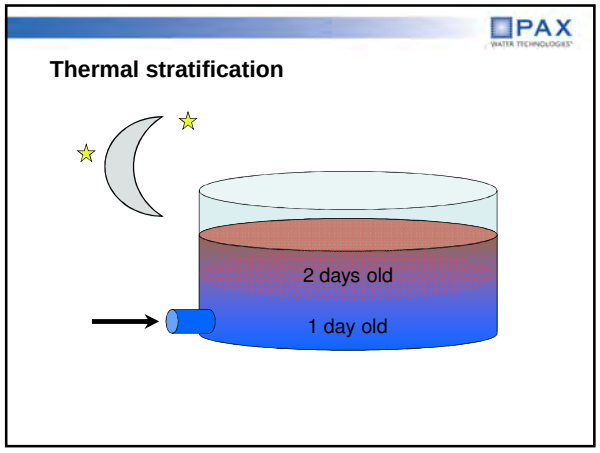

PAX
Thermal stratification
Common inlet/outlet


PAX
Thermal stratification

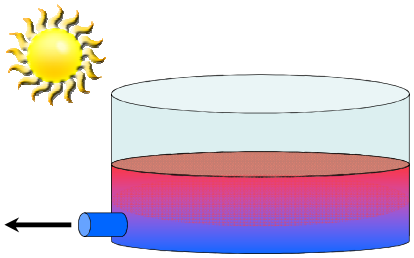

PAX
Thermal stratification


PAX
Thermal stratification
Strong and persistent thermocline established

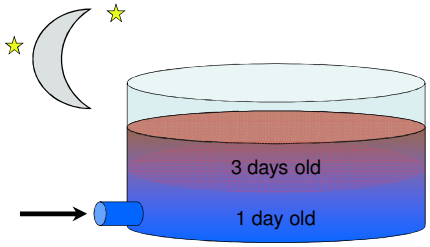

PAX
Thermal stratification


PAX
Thermal stratification
2 days old
1 day old

Thermal stratification

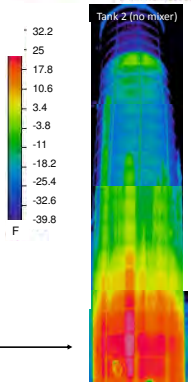


Thermal stratification



Stratified tanks can have HIGH water age…

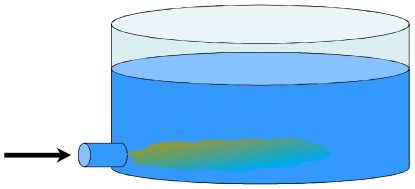
Thermal stratification also happens in winter…



Catch our webinar on ice prevention - December 8

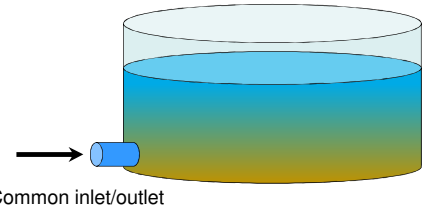
Pocket of warm water at tank bottom →

Sediment accumulates in low-velocity tank



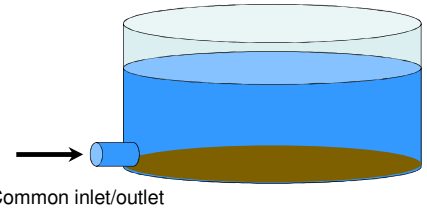
Common inlet/outlet

Sediment arrives in tank



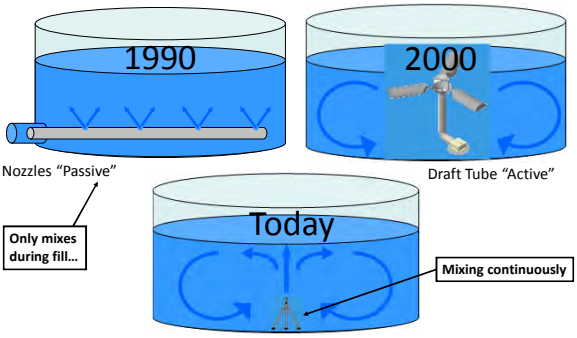
Common inlet/outlet

Sediment settles in tank



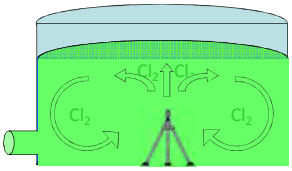
Common inlet/outlet

Mixing Technologies…



 19

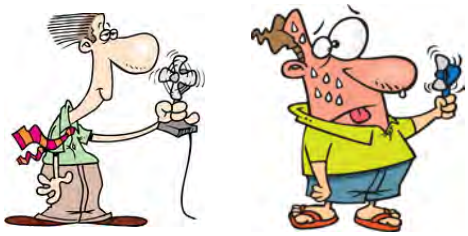
Active Mixing



Circulate fresh residual-rich water to all parts of the tank
Lower temperature in top water (and head space)
Beat back biofilm production on tank walls
Lower rate of sediment accumulation

 20

Tank Mixing: Evaluating Performance

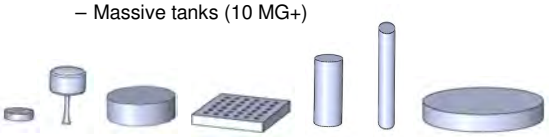


21

How much mixing does my tank need?

Depends on shape and size of tank
- Small, flat tanks
- Large flat tanks, square tanks
- Wide Standpipes
  - Narrow Standpipes
- Massive tanks (10 MG+)

Easy ↓ Hard



Easy → Hard

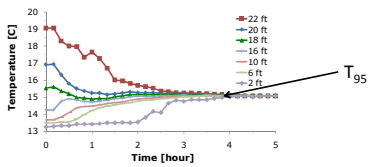
How much mixing does my tank need?

- Depends on Process Goal
  - Maintaining well-mixed conditions
  - De-stratification (thermal load)
  - Ice prevention (may need additional heat)
  - Blending a dose
  - Aeration

Less Power ↓ More Power

Key Performance Metric: Blend time

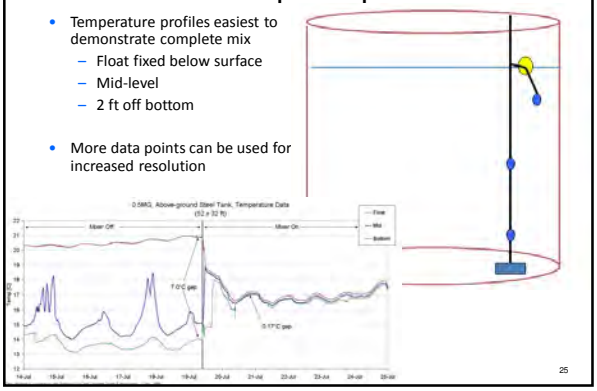
- T_B = Blend time
- T_B is the time to blend an initially unmixed tank to a blended condition
  - T_{90} = time to reduce variation to 10% of its initial condition
  - T_{95} = time to reduce variation to 5% of its initial condition



 24

Performance Metrics: Temperature profile

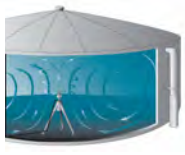
- Temperature profiles easiest to demonstrate complete mix
  - Float fixed below surface
  - Mid-level
  - 2 ft off bottom
- More data points can be used for increased resolution



25

Performance Metrics: Chemistry profile

- Chemistry most informative
  - Grab samples
  - Total or free chlorine
  - Top & bottom samples minimum
- More data points can be used for increased resolution



26

New white paper:
How to Select and Specify Mixers for Potable Water Storage Tanks

Download at
www.paxwater.com

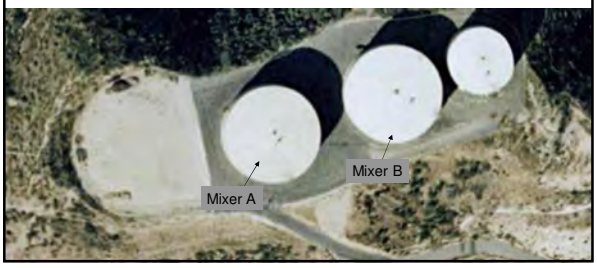
27

Full-Scale Utility Case Studies

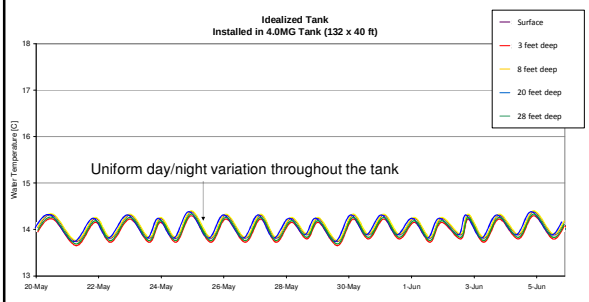
28

Side-by-side comparison of mixing systems for thermal de-stratification – Southern CA

- 4.0MG Tanks, 132 x 40 ft
- Equal sunlight, equal water

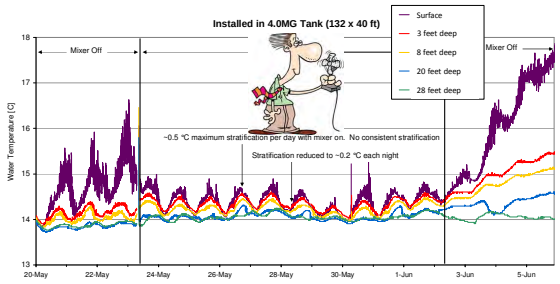


Ideally Mixed Tank



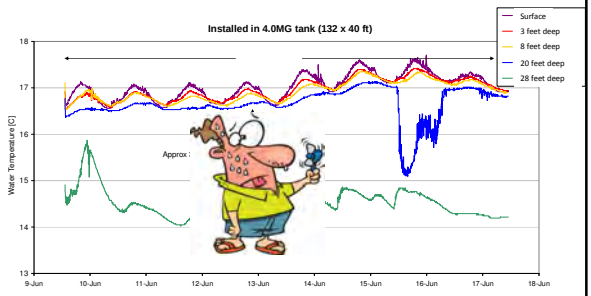
30

Mixer A Results



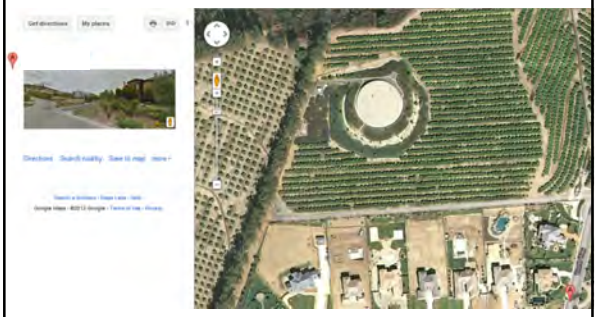
 31

Mixer B Results

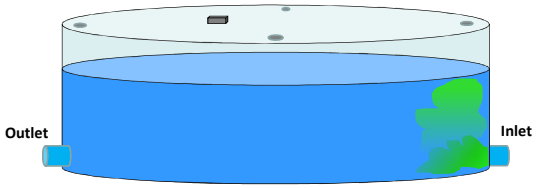


 32

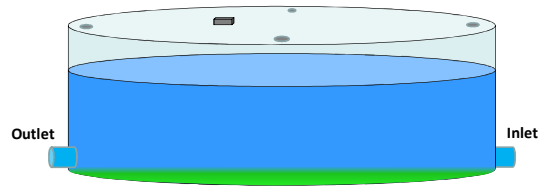
Side-by-side comparison of mixing systems for residual blending – Southern CA



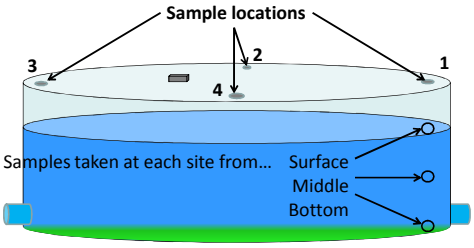
Outlet / Inlet

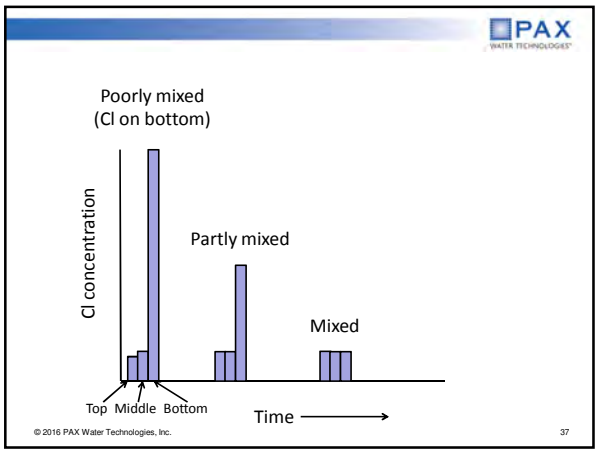


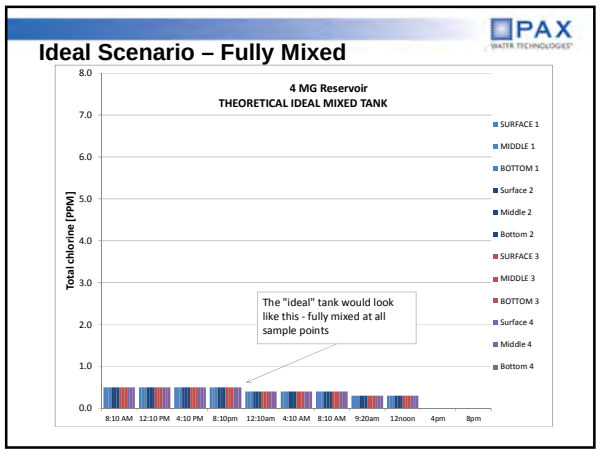
Outlet / Inlet

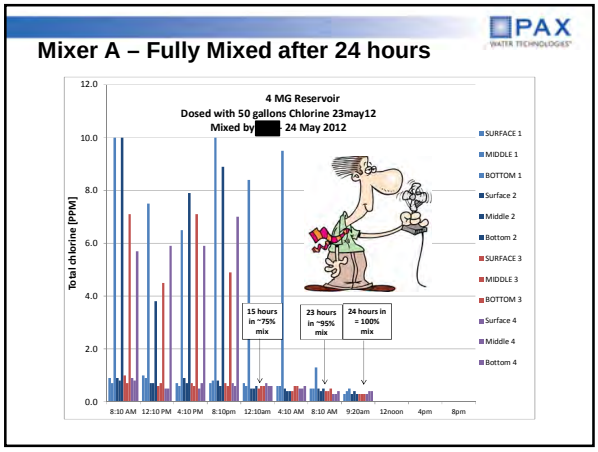


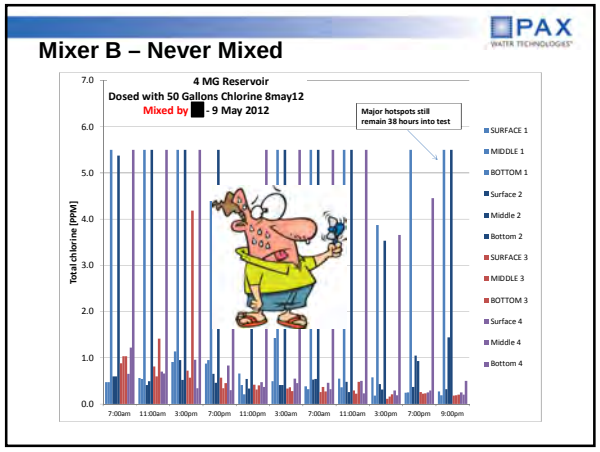
Sample locations

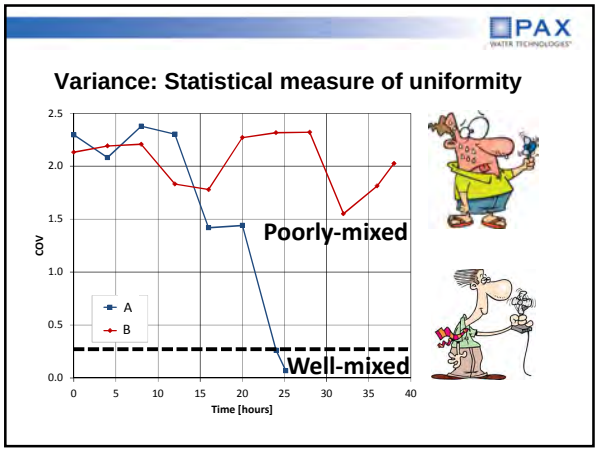


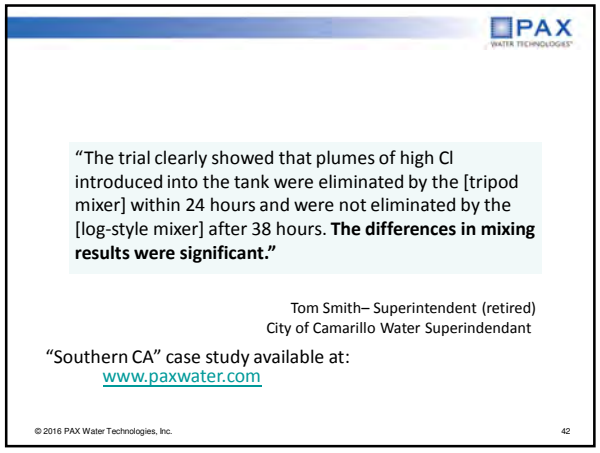

Poorly mixed
(Cl on bottom)
Cl concentration
Partly mixed
Mixed
Top Middle Bottom
Time
© 2016 PAX Water Technologies, Inc.
37


Ideal Scenario – Fully Mixed
4 MG Reservoir
THEORETICAL IDEAL MIXED TANK
Total chlorine [PPM]
The "ideal" tank would look like this - fully mixed at all sample points
SURFACE 1
MIDDLE 1
BOTTOM 1
Surface 2
Middle 2
Bottom 2
SURFACE 3
MIDDLE 3
BOTTOM 3
Surface 4
Middle 4
Bottom 4


Mixer A – Fully Mixed after 24 hours
4 MG Reservoir
Dosed with 50 gallons Chlorine 23may12
Mixed by [redacted] - 24 May 2012
Total chlorine [PPM]
15 hours in ~75% mix
23 hours in ~95% mix
24 hours in = 100% mix


Mixer B – Never Mixed
4 MG Reservoir
Dosed with 50 Gallons Chlorine 8may12
Mixed by [redacted] - 9 May 2012
Major hotspots still remain 38 hours into test
Total chlorine [PPM]


Variance: Statistical measure of uniformity
COV
Poorly-mixed
Well-mixed
A
B
Time [hours]


"The trial clearly showed that plumes of high Cl introduced into the tank were eliminated by the [tripod mixer] within 24 hours and were not eliminated by the [log-style mixer] after 38 hours. The differences in mixing results were significant."
Tom Smith– Superintendent (retired)
City of Camarillo Water Superindendant
"Southern CA" case study available at:
www.paxwater.com
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42

Mixing Power makes the Difference for Ice Prevention and THM reduction

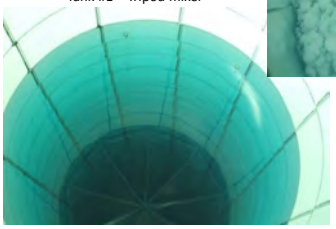
43

- Some mixing systems are advertised to "reduce ice formation"
- You don't want "reduction" – you want ELIMINATION

Mixing Power makes the difference

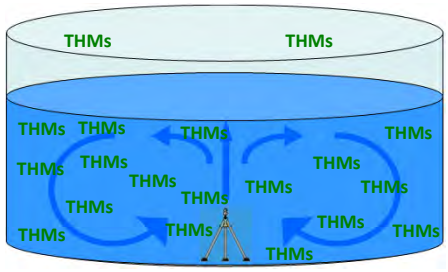
A powerful active mixing system can save you $100K in tank damage

Tank #1 – Tripod mixer



Tank #2 – No mixer

A powerful mixer can reduce THMs



But you need STRONG mixing

Key take-away points:

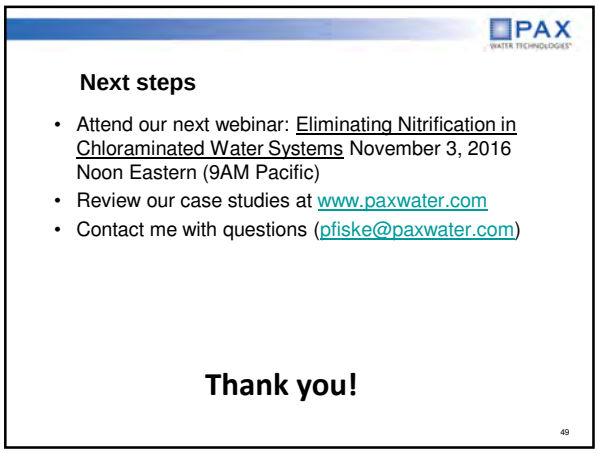
- Active tank mixing provides value by:
  - Eliminate thermal and chemical stratification and reducing residual loss
  - Stabilize and improve residual levels
  - Lower headspace temperatures/reducing corrosion
  - (with ventilation) reducing THMs
  - Eliminating ice formation
- Select based on documented performance
  - Blend time measurements
  - Achievement of process goals
    - "Partially mixed", "Reduction in ice formation" – don't cut it
  - Mixer equipment costs vary by a factor of 3x
    - Mixing power varies by a factor of 12x

47

Your tanks are a valuable (and expensive) municipal asset…

EFFECTIVE MIXING can stabilize and improve your water quality

Mixing Power makes the difference


PAX
WATER TECHNOLOGIES
Next steps
• Attend our next webinar: Eliminating Nitrification in Chloraminated Water Systems November 3, 2016 Noon Eastern (9AM Pacific)
• Review our case studies at www.paxwater.com
• Contact me with questions (pfiske@paxwater.com)
Thank you!
49