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# **TTHM Reduction Measures in the Distribution System**

*Mark Graves, P.E.*

# DBP Formation

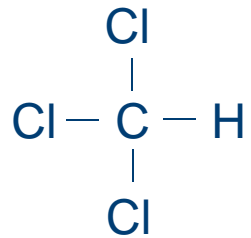
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Disinfectant + Precursor = DBP's

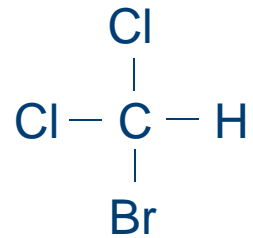
Chlorine + Organic Matter = Trihalomethanes  
Bromide = Haloacetic Acids

# Trihalomethanes (THM)

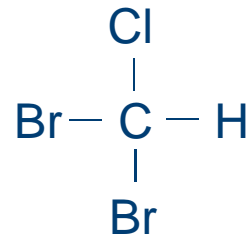
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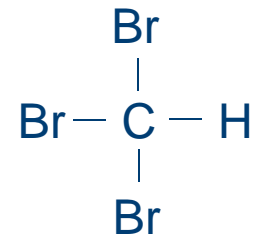
Chloroform



Dichlorobromo-  
methane



Dibromochloro-  
methane



Bromoform

# Stage 2 DBP Rule

## Stage 1 Rule

THM 80 ug/L  
HAA 60 ug/L

DBP  
locations

System-wide  
RAA

2001

I D S E  
2006-  
2009

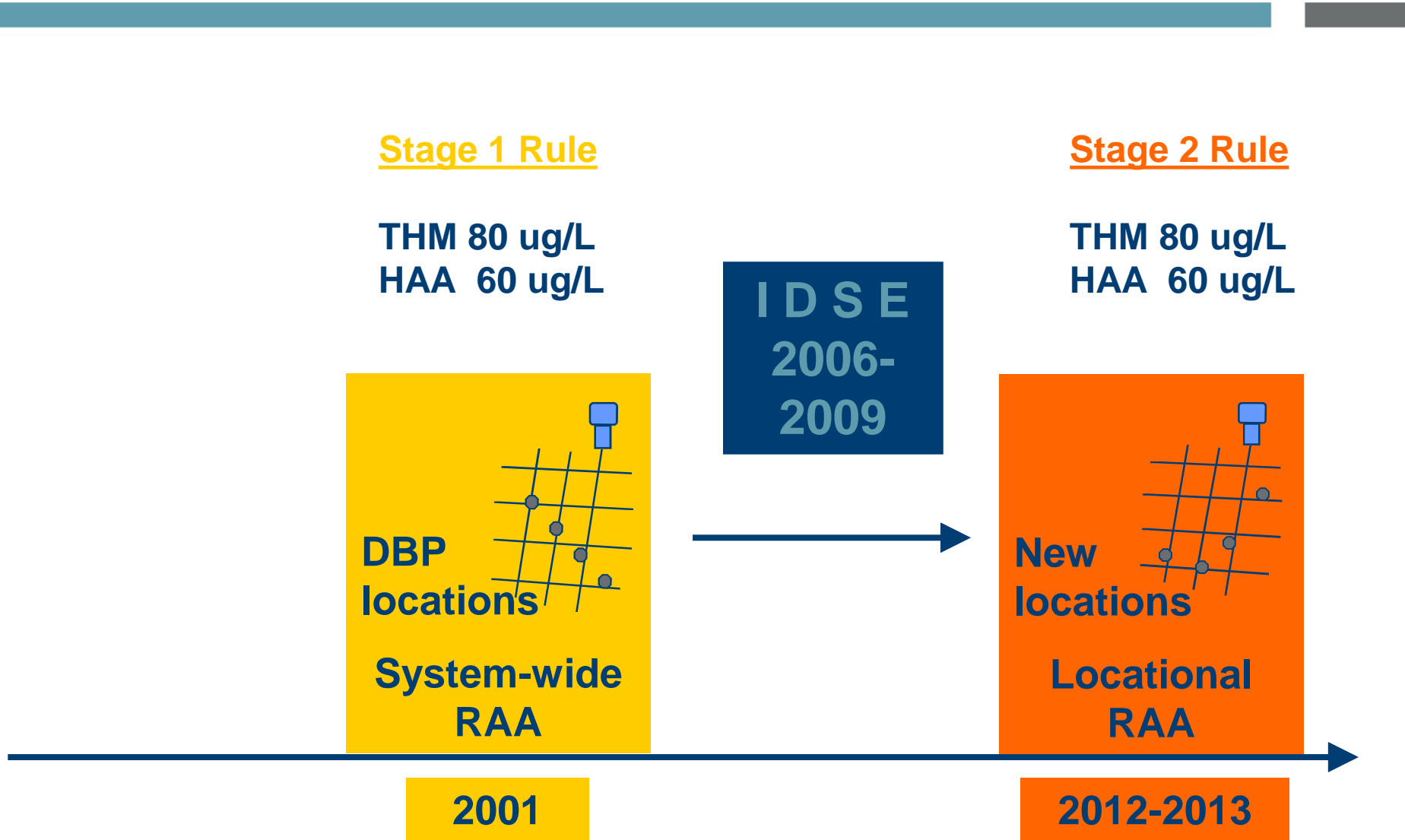
## Stage 2 Rule

THM 80 ug/L  
HAA 60 ug/L

New  
locations

Locational  
RAA

2012-2013



# General Impact on DBP Formation

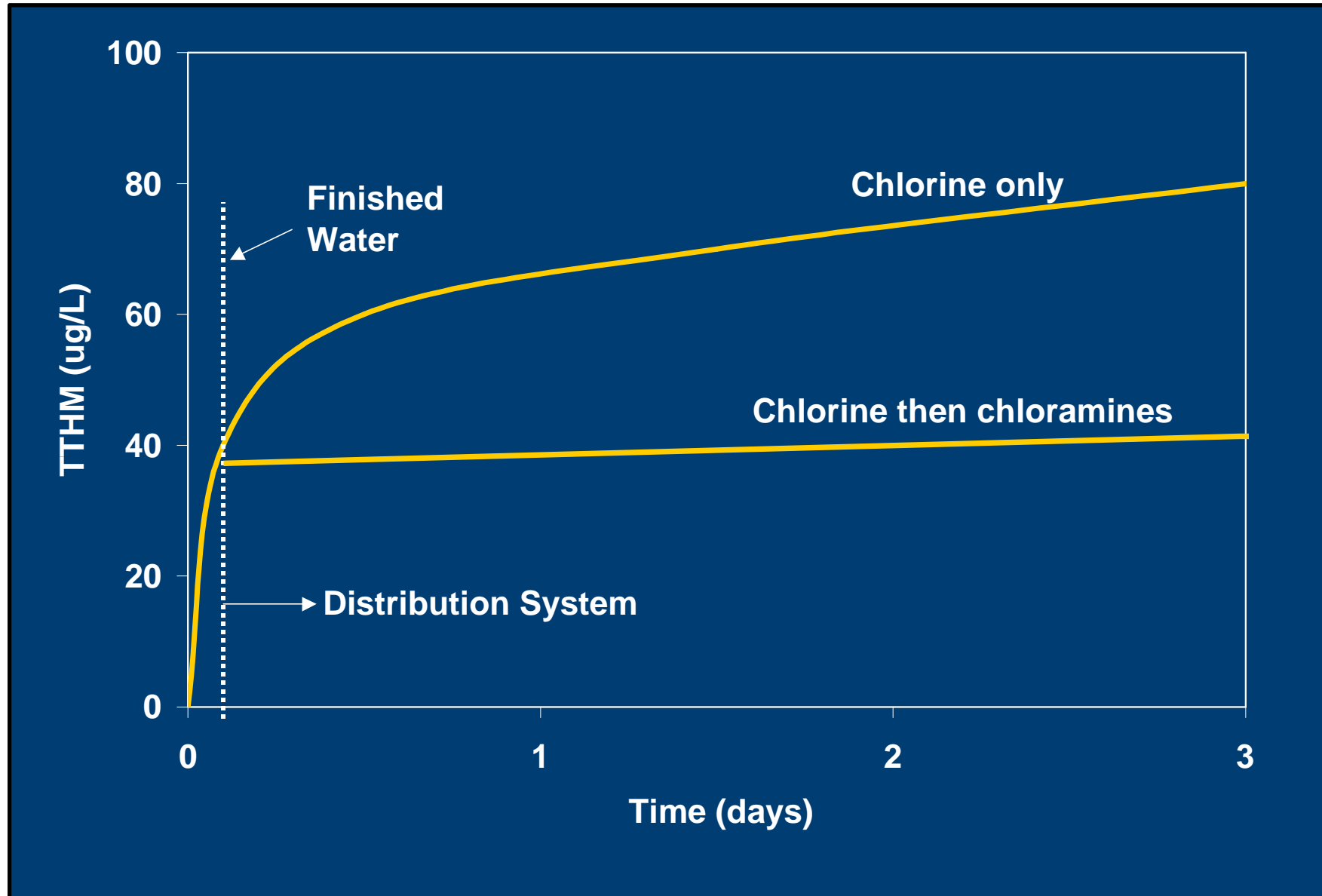
Parameter (Increasing)	TTHM	HAA5
TOC	↑	↑
Time	↑	↔
Temperature	↑	↑
Disinfectant Dose	↑	↑
pH	↑	↓
Bromide	↑	↑

# TTHM Control Options

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- Prevent TTHM Formation
  - Disinfectant Selection – Chloramines (May require free chlorine to blend with existing supplies)
  - Chlorine Dose – Free chlorine dose minimized
  - Reduce Organics
    - Enhanced coagulation at WTP
    - Additional organics removal treatment – GAC, Ion Exchange
  - Control Detention Time
- Remove TTHMs After Formed
  - Adsorption – activated carbon
  - Aeration – Spray, tray/tower cross flow, diffused in tank

# TTHM Formation Profile



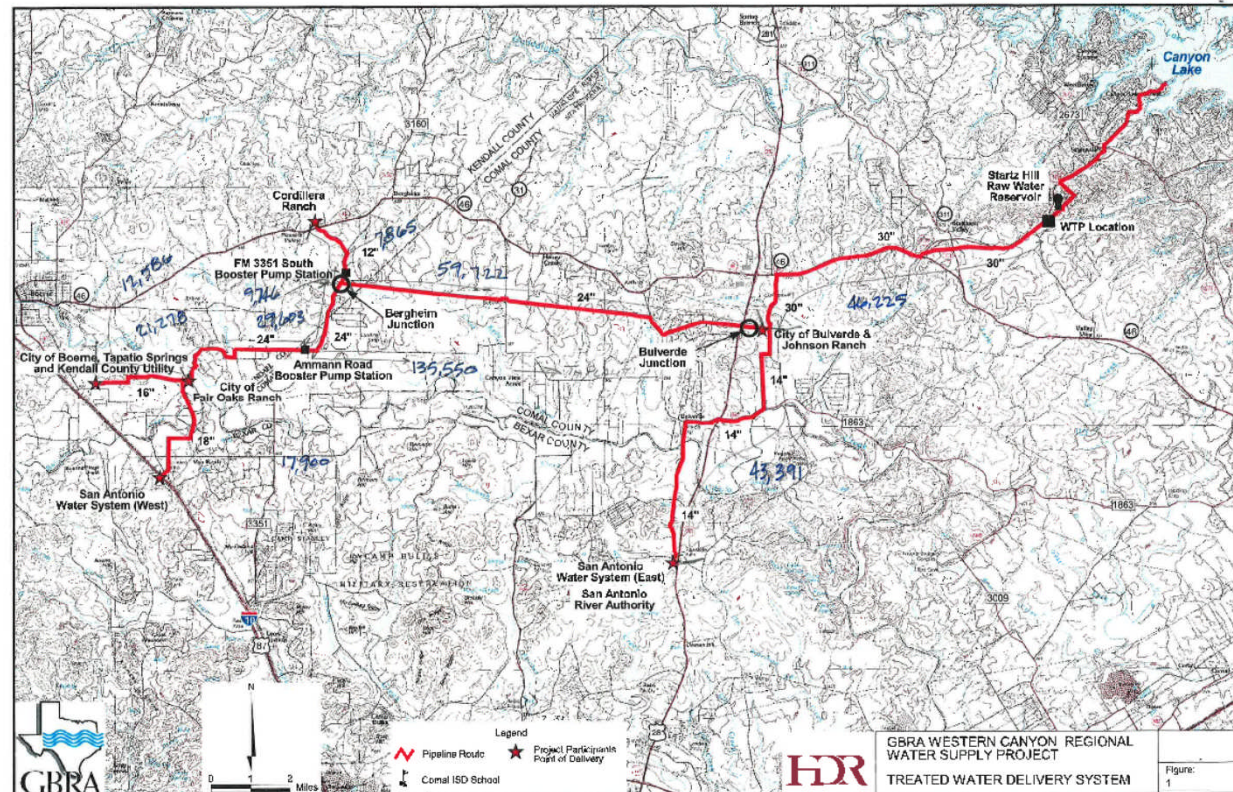
# Minimize Distribution System Formation

- Minimize Detention Time
  - Dead Ends
    - Loop Piping
    - Systematic Manual Flushing
    - Automatic Flushing
  - Storage Tank Water Level Optimization
- Disinfectant Residual Control



# Example – Western Canyon Transmission

- 33 miles of pipe
- 40 hour transmission time
- Chlorine boosted at tank



# Tank Total Trihalomethanes (TTHM)

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- Entering Tank TTHM = 45 ug/L
- Low winter water demand → Increased TTHM
  - Increased detention time
  - Less groundwater blending

OEV = Average of (2 x current quarter TTHM + two previous quarters TTHM)

# Bench Scale Aeration Tests

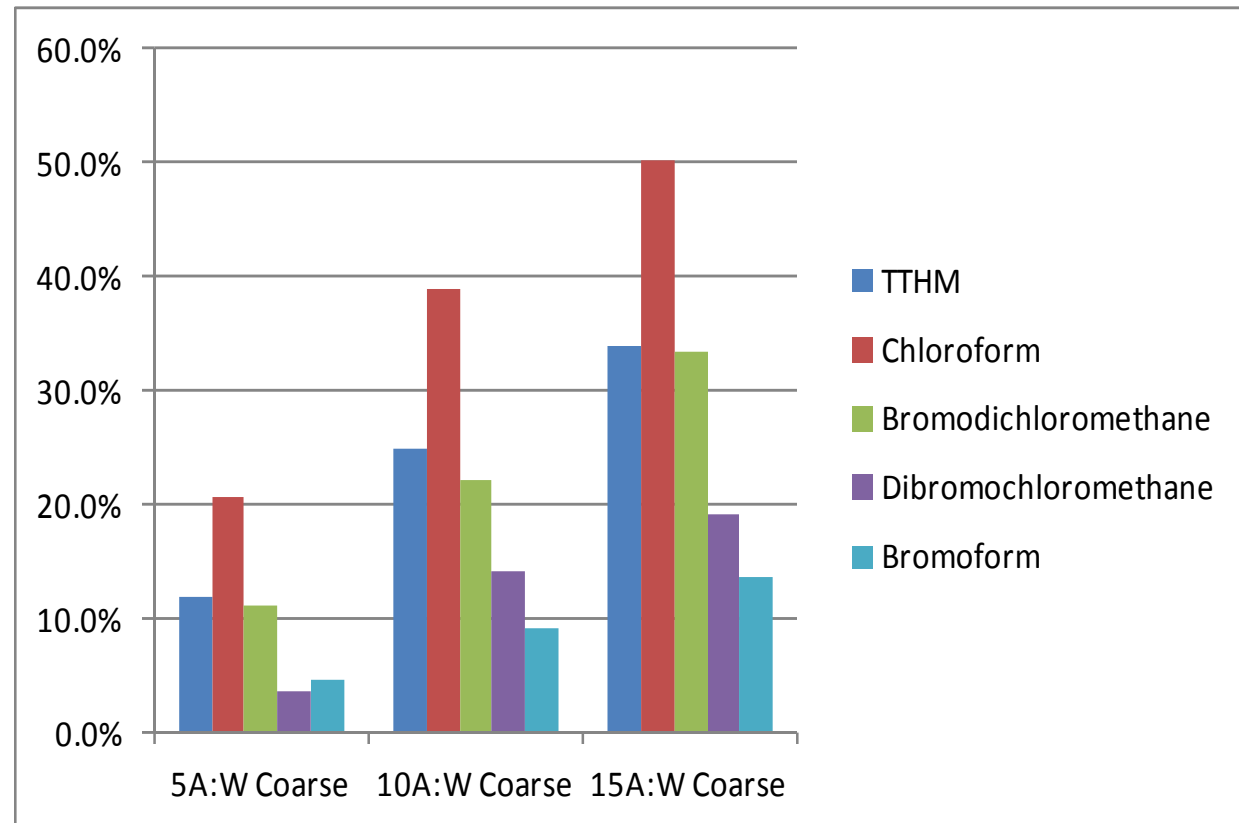
- Evaluate Western Canyon water characteristics
- TTHM formation profile
- Diffused in-tank aeration TTHM removal performance



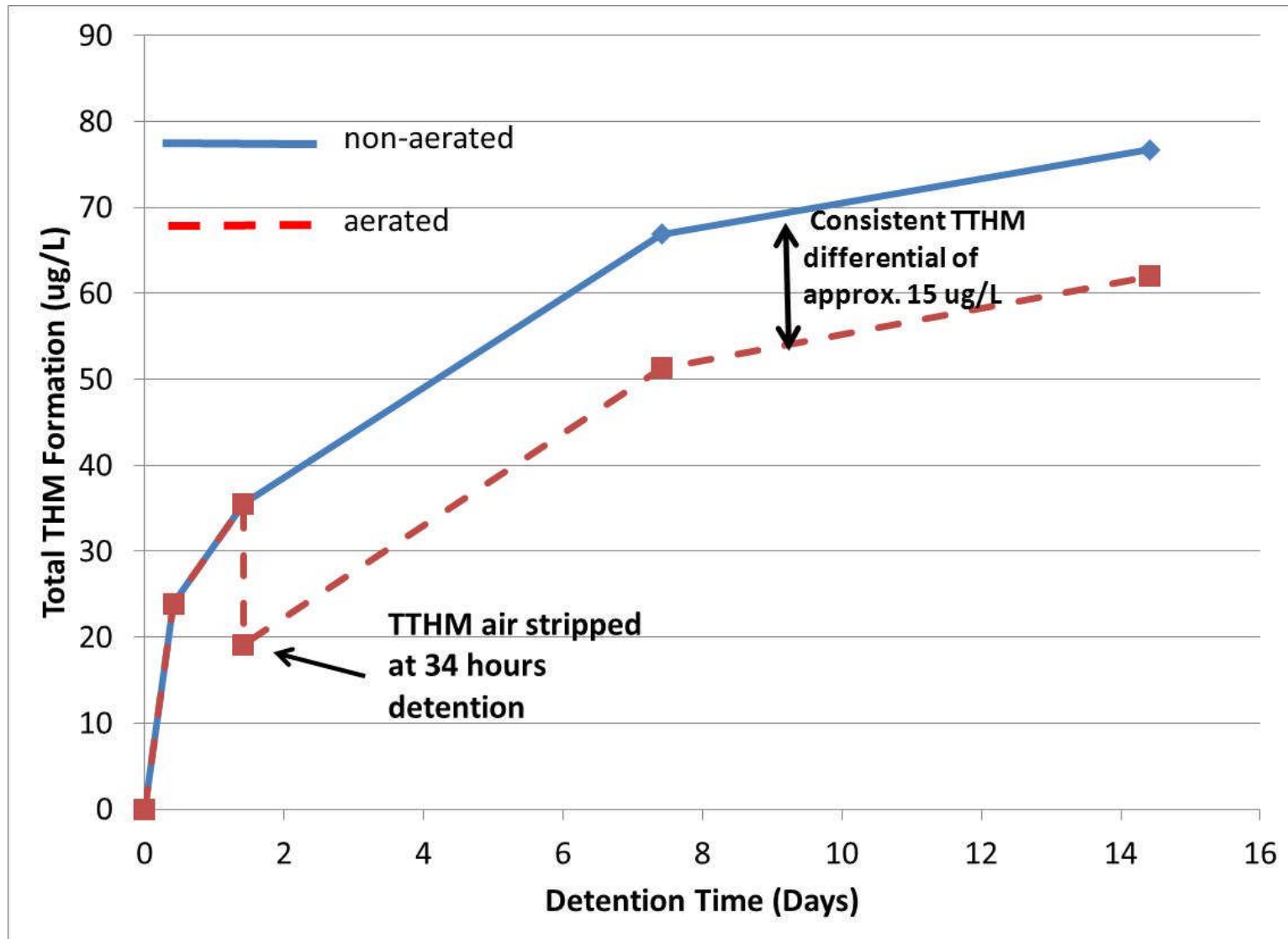
Course Bubble Aeration

# Western Canyon Aeration

- Tested Air to Water Ratios from 5:1 to 15:1
- High bromine TTHMs in Western Canyon
- Bromine TTHMs more difficult to aerate



# TTHM in Aerated and Non-aerated Surface Water



# Bench Scale Aeration Tests

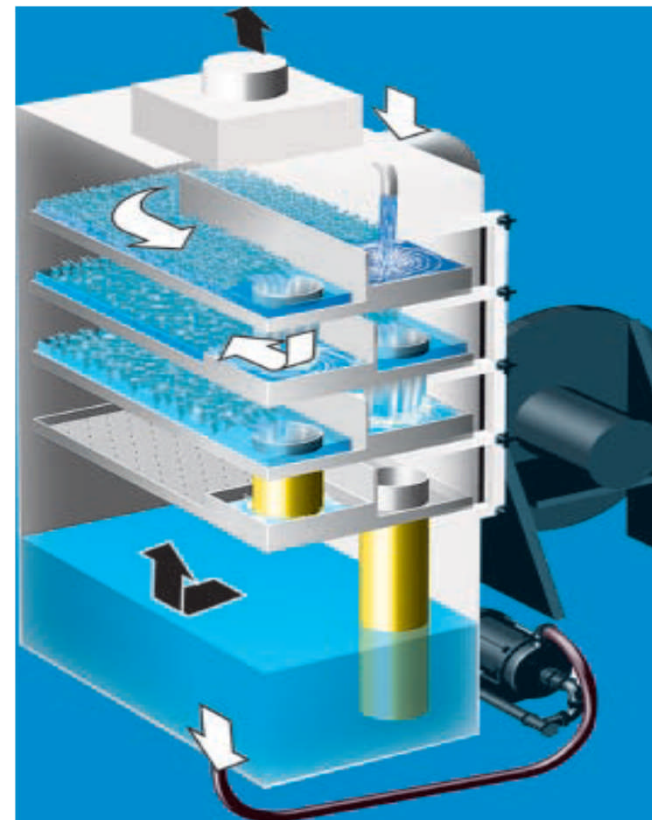
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- Results of bench scale study:
  - TTHMs stripped do not reform
  - Absolute value of TTHMs removed reduces overall TTHM formation potential (TTHMFP)
  - Air stripping does not halt production of TTHMs
- SAWS West formation potential
  - 40% reduction of TTHM by in tank aeration
  - High air to water ratio (15:1) needed
  - 40% reduction at Winwood Tank sufficient to decrease West TTHM below 80 ug/L

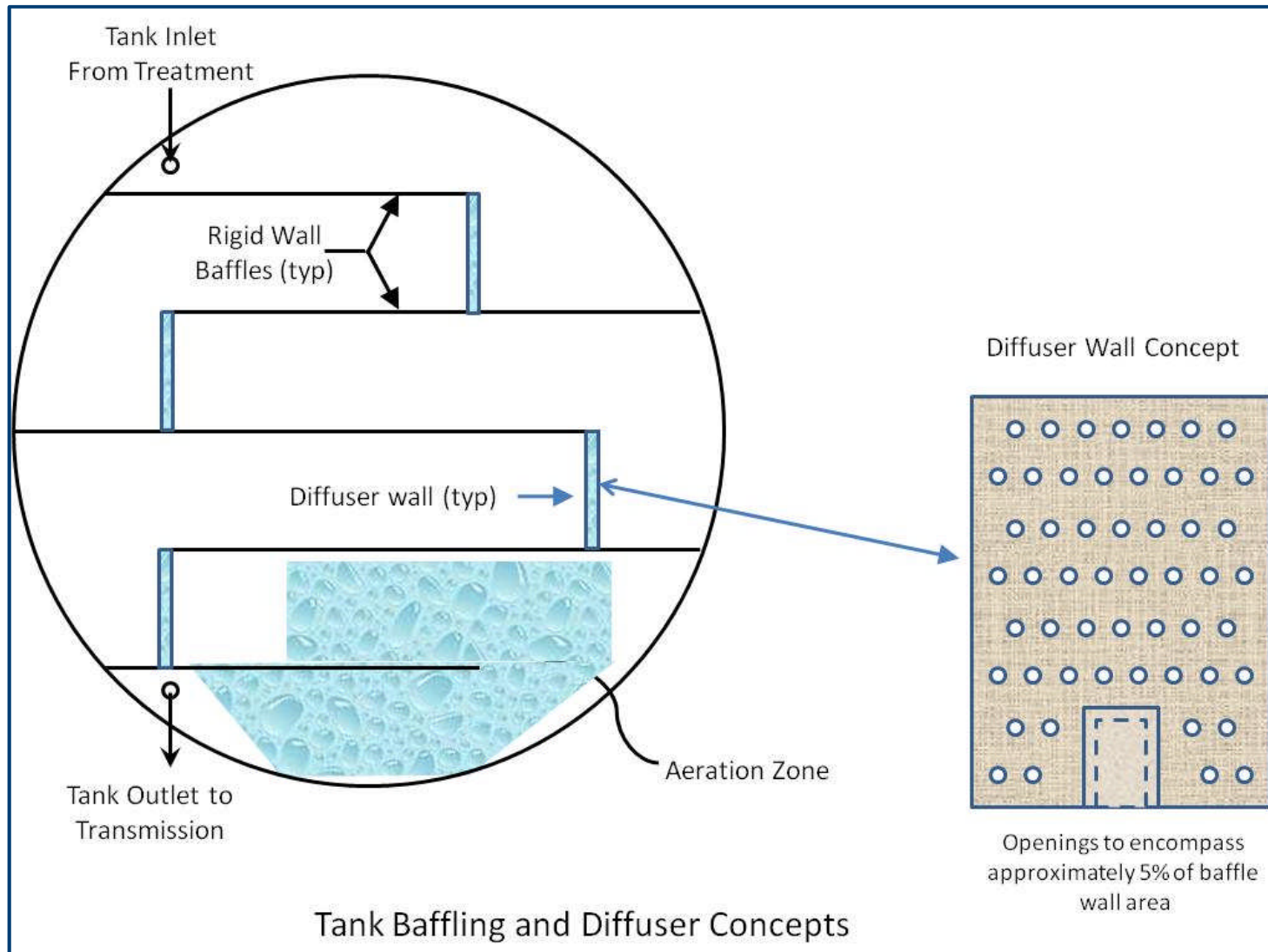
# Aeration Options

- In Tank Aeration
  - Blowers and Diffusers
  - Spray Aeration
- Stand Alone Cross Flow
  - Tray Aerator
  - Packed Tower

Tray Aerator



# Example In Tank Aeration for TTHM Stripping



# Aeration Option Advantages and Drawbacks

Method	Advantages	Drawbacks
Packed Tower	<ul style="list-style-type: none"> <li>• Efficient at removing TTHM</li> <li>• Requires less floor space than most alternatives.</li> <li>• Multiple vendors.</li> </ul>	<ul style="list-style-type: none"> <li>• Surface water will promote fouling of media.</li> <li>• Potential coliform growth in media low flow zones</li> <li>• Re-pump water required</li> <li>• Requires tall (15 – 30 ft) towers.</li> <li>• Maintenance difficulties including;</li> <li>• Access to the top of the tower requires a tall ladder.</li> <li>• Media cleaning requiring complete shutdown of tower.</li> <li>• Adding or replacing media can be difficult.</li> </ul>
Tray Aeration	<ul style="list-style-type: none"> <li>• Shorter height</li> <li>• Easier access to all of tower internal structure.</li> <li>• Trays can be cleaned without shutting down all aeration.</li> <li>• Multiple vendors.</li> </ul>	<ul style="list-style-type: none"> <li>• Requires greater surface area and larger footprint.</li> <li>• Periodic maintenance to clean trays</li> <li>• Re-pump water required</li> </ul>
In Tank Aeration	<ul style="list-style-type: none"> <li>• Could be retrofitted into existing tank.</li> <li>• Least amount of floor space required.</li> <li>• Familiar process (though on wastewater).</li> <li>• Process can be expanded by adding additional diffusers.</li> <li>• Least likely to need maintenance of diffusers.</li> <li>• Multiple vendors.</li> </ul>	<ul style="list-style-type: none"> <li>• Requires extensive modification of tank for air handling.</li> <li>• Less efficient method for removing TTHM.</li> <li>• Largest blowers and highest energy requirements.</li> </ul>

# Understand DBPs in System

- Traditional DBP testing
  - Collect Sample and Send to Lab
  - Results in 2 to 3 weeks
- On-line and Grab Sample TTHM Analyzers
  - Real Time Results Allow System Optimization
  - Results are Consistent with Lab



Dimensions  
2' x 5'

Weight – 100lbs  
(45.3kg)



# Conclusions

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- Control DBPs at Treatment
- Minimize Detention and Dose
- TTHM Removal Options
  - At Water Treatment Plant
  - In the Distribution System

# Questions

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