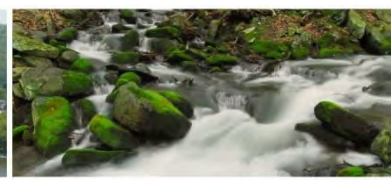




pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Bureau of Safe Drinking Water



Pennsylvania DEP Technical Assistance Program: Distribution System Optimization

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Agenda

- Overview of Distribution System Optimization Program
- Approaches
- Hold Study Protocol
- Storage Tank Evaluations

Overview

- The Distribution System Optimization Program aims to provide assistance to systems seeking to improve water quality.
 - Disinfectant residual maintenance
 - Disinfection byproduct formation
 - Storage tank operations and impacts
- Focus on operational changes and best management practices

Approaches

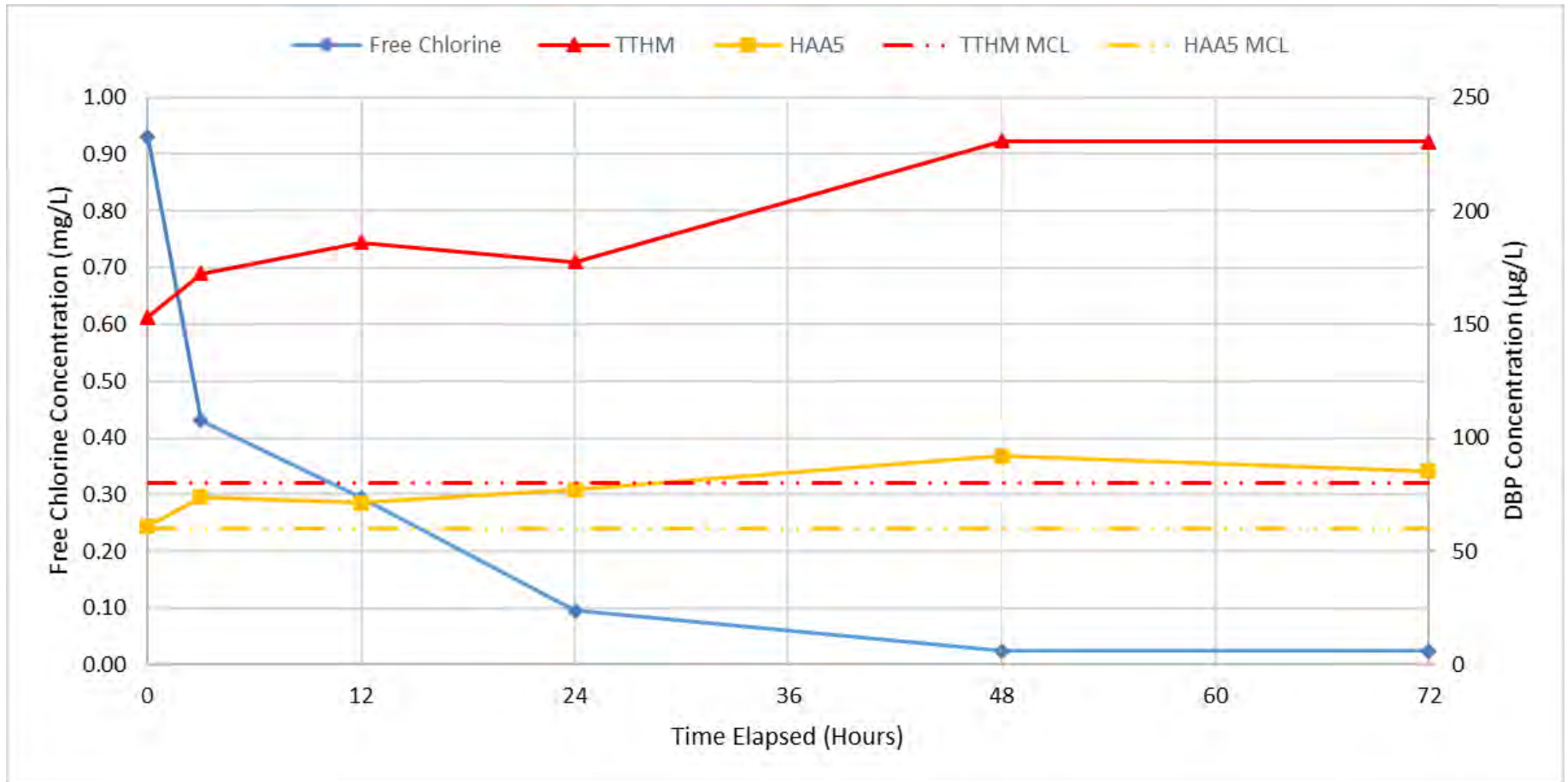
- Utilize various special studies based on specific areas of concern
 - In-plant water quality profiling
 - Hold studies to assess water stability
 - Investigative sampling and water quality mapping
 - Assessment of storage tank turnover, mixing, and impact
 - Continuous disinfectant residual monitoring

Hold Study Protocol

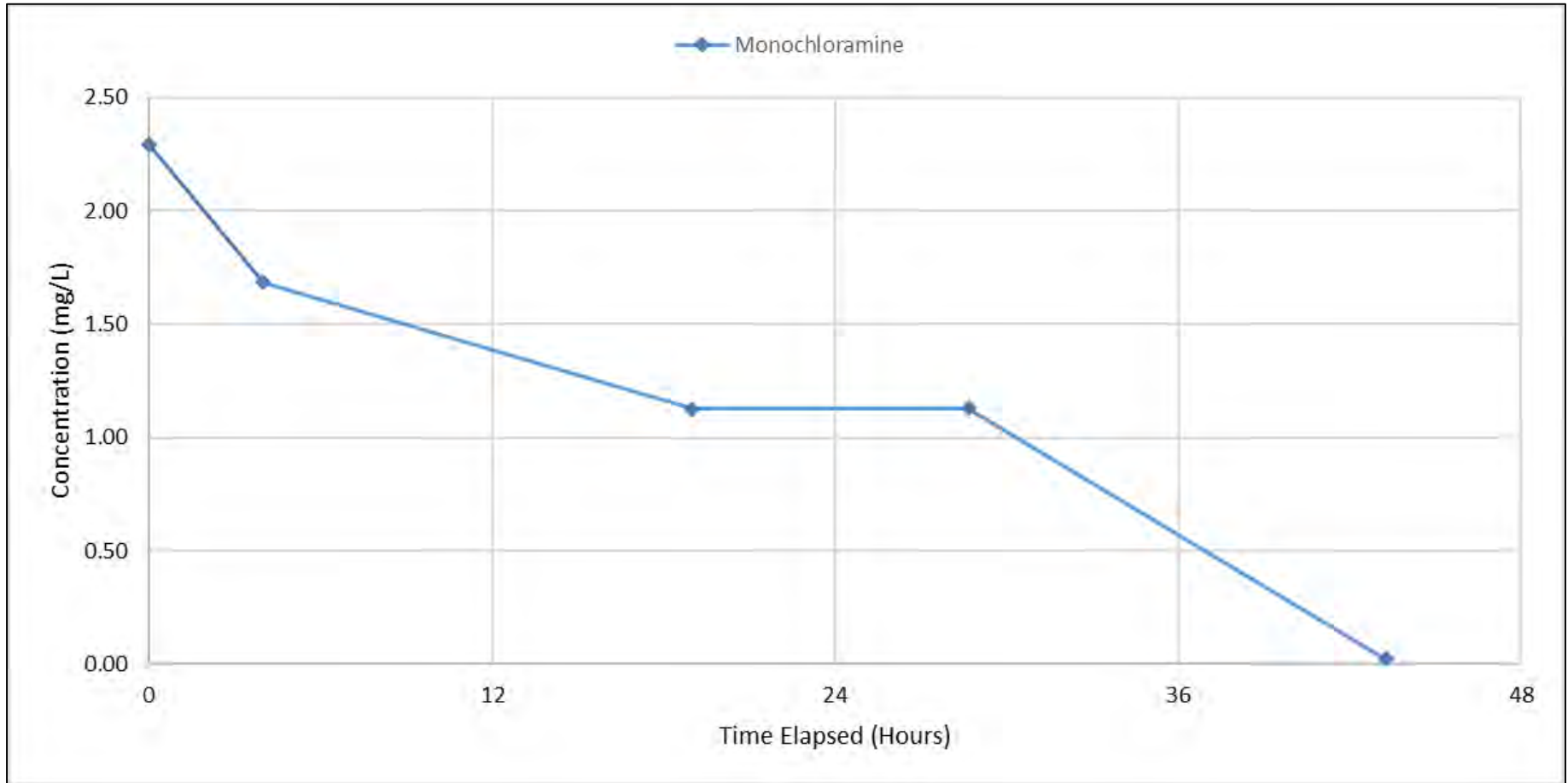
- Simulate chlorine decay and DBP formation
 - Entry Point, storage tanks, booster stations
 - Free chlorine or chloramines
- Collect water and hold at distribution temperature
- Monitor water quality at set intervals



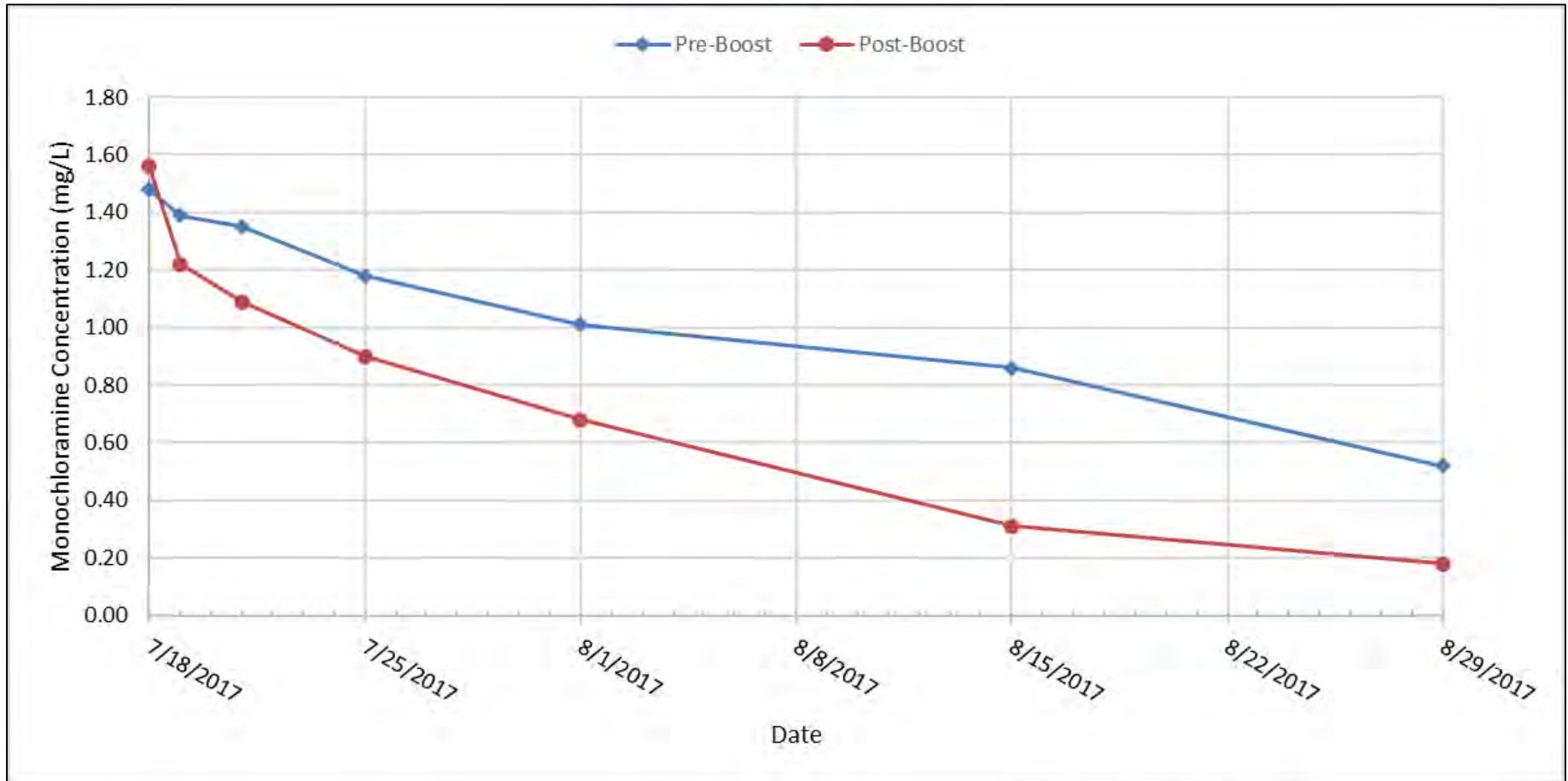
Free Chlorine Hold Study



Chloramine Hold Study



Booster Chlorination Hold Study



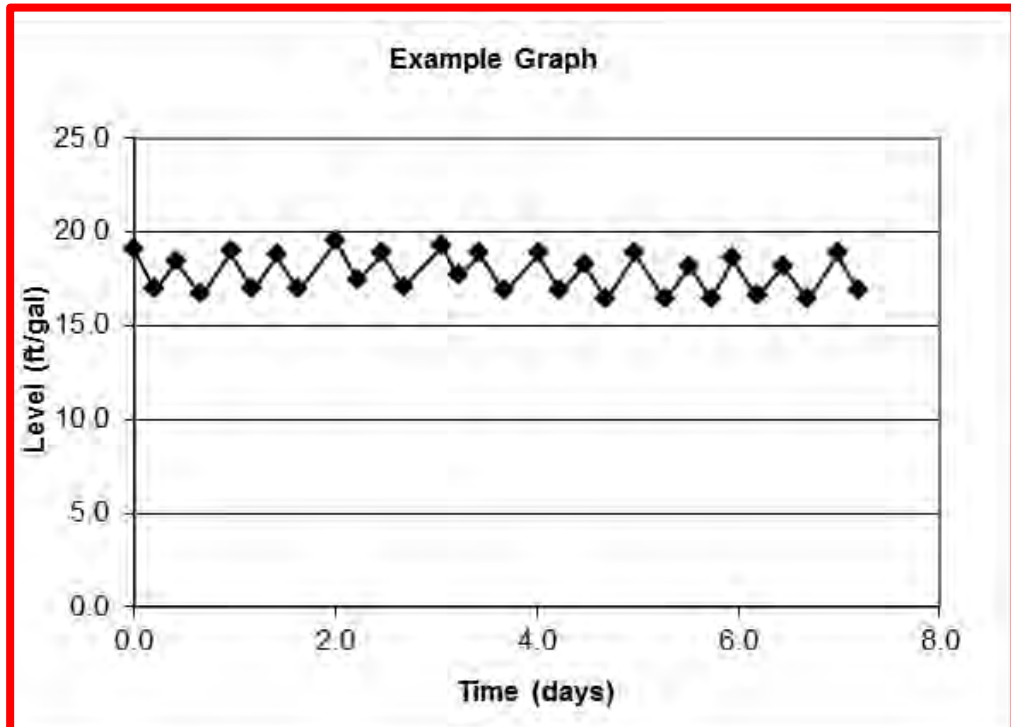
Storage Tank Monitoring & Impacts

- Storage Tank Assessment Spreadsheet
 - Mixing performance and tank turnover
 - Impact of operational strategies
- Field approaches
 - In-tank water quality monitoring
 - Temperature data loggers to assess thermal stratification
 - Continuous disinfectant residual monitoring



Storage Tank Assessment Spreadsheet

- **Outputs**
 - Tank level trend
 - Turnover time
 - Volume exchange
 - Fill/draw times
 - Mixing ratio



Turnover Summary		Turnover Summary	
Avg Vol Added in One Fill Period	0.03	MG	
Avg Vol Drawn in One Drain Period	0.03	MG	
Avg Fill Time	0.27	days	
Avg Draw Time	0.22	days	
Avg Fill Rate	71	gpm	
Avg Draw Rate	88	gpm	
Avg Duration (Fill + Draw Time)	0.5	days	
Avg Flow Rate into tank	0.06	MGD	
Avg Tank Vol	0.28	MG	
Turnover Time	0.06	MGD	4.6
	0.26	MG	
	4.6	days	

Turnover Time is at a desired level.

Mixing Summary		
Avg Min Water Level	16.8	ft
Avg Actual VEF	0.11	
Avg VEF Needed for Good Mixing	0.28	
Avg Measured Water Level Change	1.9	ft
Desired Water Level Change Needed for Good Mixing	4.7	ft
Mixing Performance Ratio (Measured/Desired)	0.41	
Inlet Diameter Needed for Good Mixing	5	inches

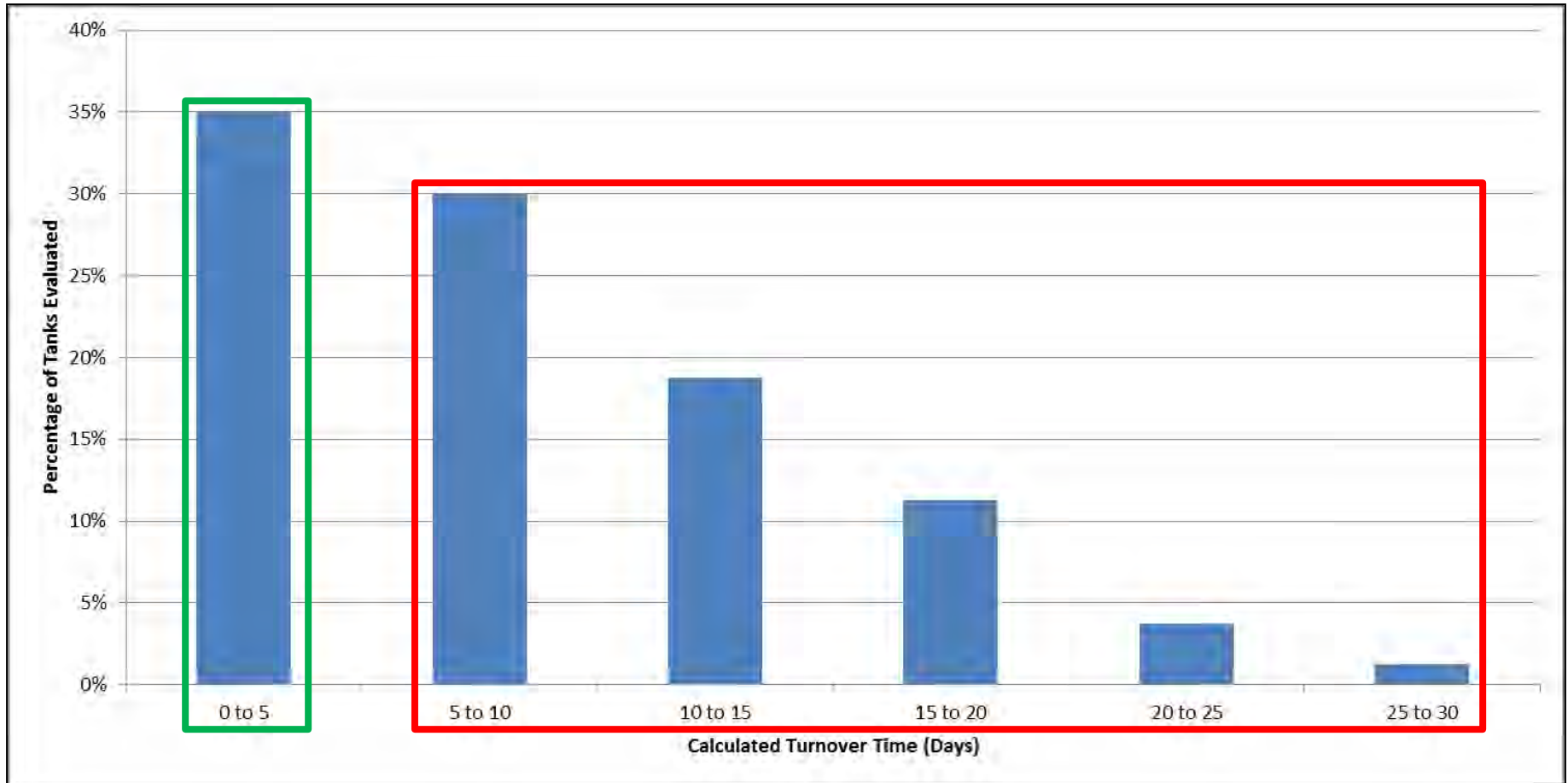
Mixing is at an undesirable level, use Mixing Analysis (Step 2) to determine strategies that will increase mixing.

Storage Tank Assessment Spreadsheet

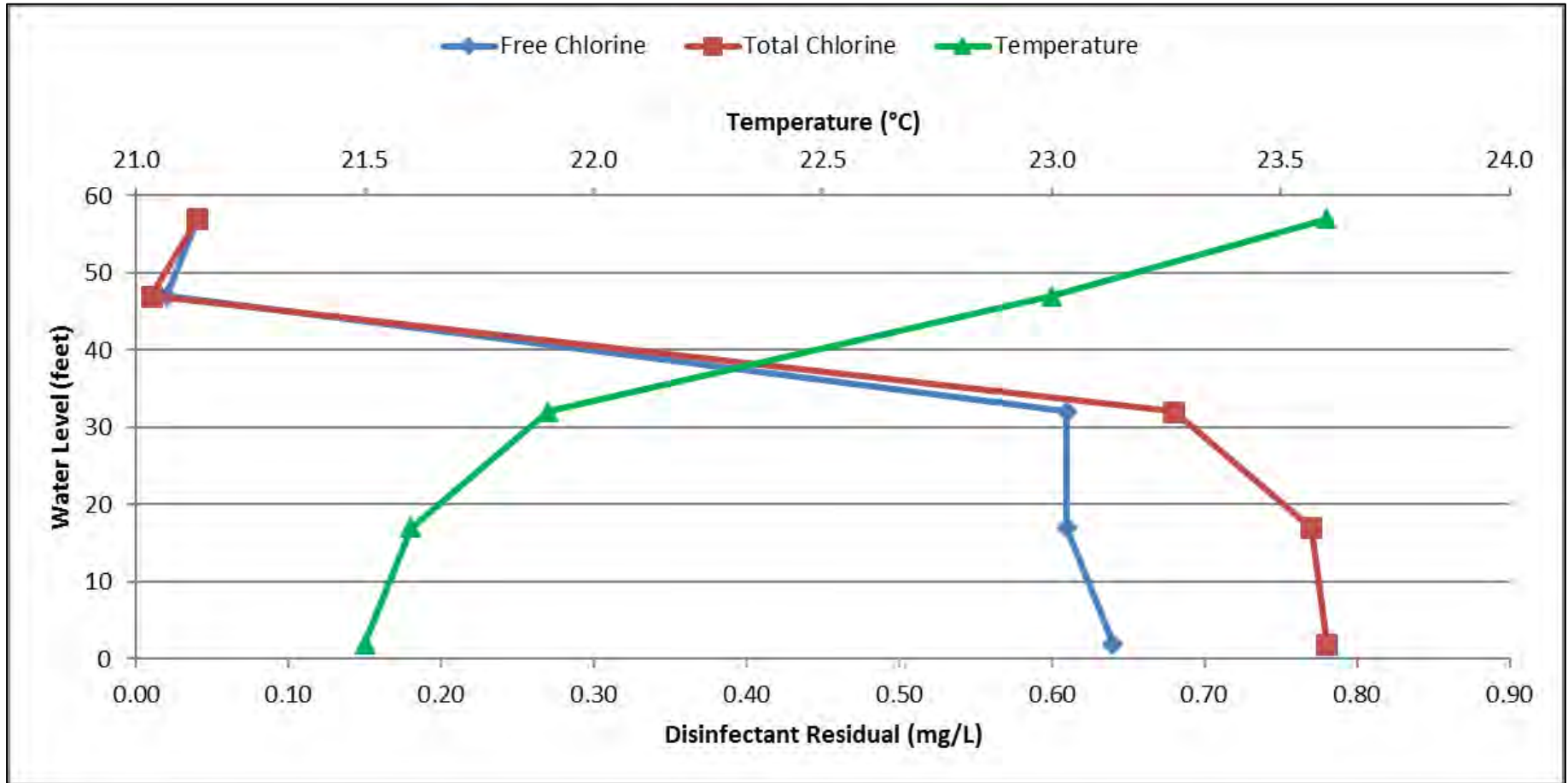
- Estimate effect of changes on tank performance
 - Minimum level
 - Maximum level
 - Fill duration
 - Inlet diameter
- Inlet/outlet and tank shape limitations

	No Changes	Scenario A
Tank diameter	50	50
	0	0
Inlet Diameter	1.00	1.00
High/Max Level	18.71	17.00
Low/Min Level	16.79	15.00
H/D ratio	0.37	0.34
Actual Level Change	1.92	2.00
Dimensionless Mixing Time	10.20	10.20
Desired Level Change Needed for Good Mixing	4.73	4.38
Pressure Drop After Change in Min Water Level		0.8
Fill rate/ Pumping rate	71	71
Draw rate/ consumer demand	88	88
Avg fill time	0.27	0.29
Avg draw time	0.22	0.23
Avg volume added during fill	0.03	0.03
Avg Duration (fill +draw)	0.50	0.52
Ave Flow Rate	0.06	0.06
Ave Tank Vol	0.26	0.24
Mixing Performance Ratio (Measured/Desired)	0.41	0.46
Turnover Time	4.6	4.2

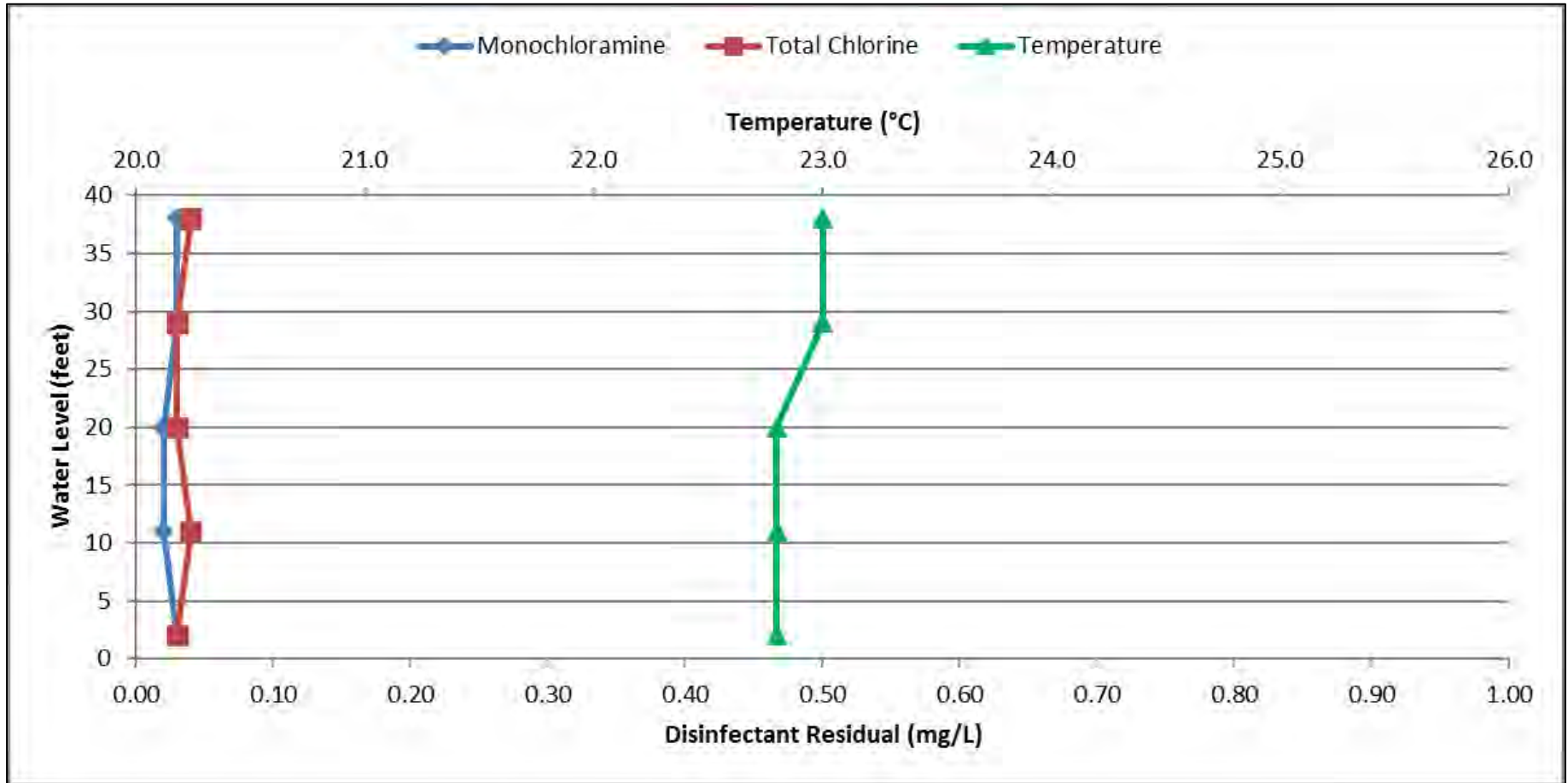
Summary of Assessed Tanks



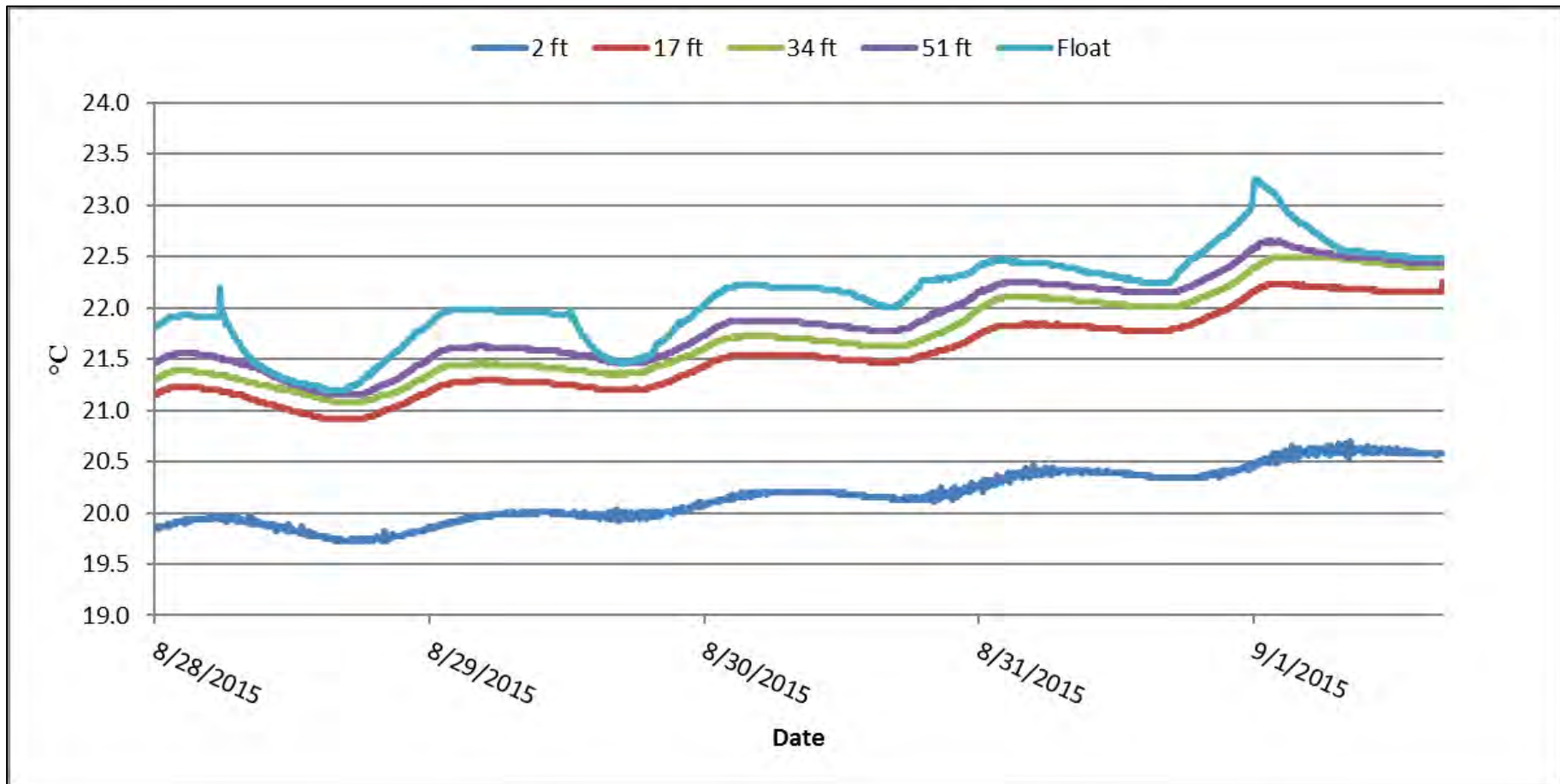
Unmixed Standpipe



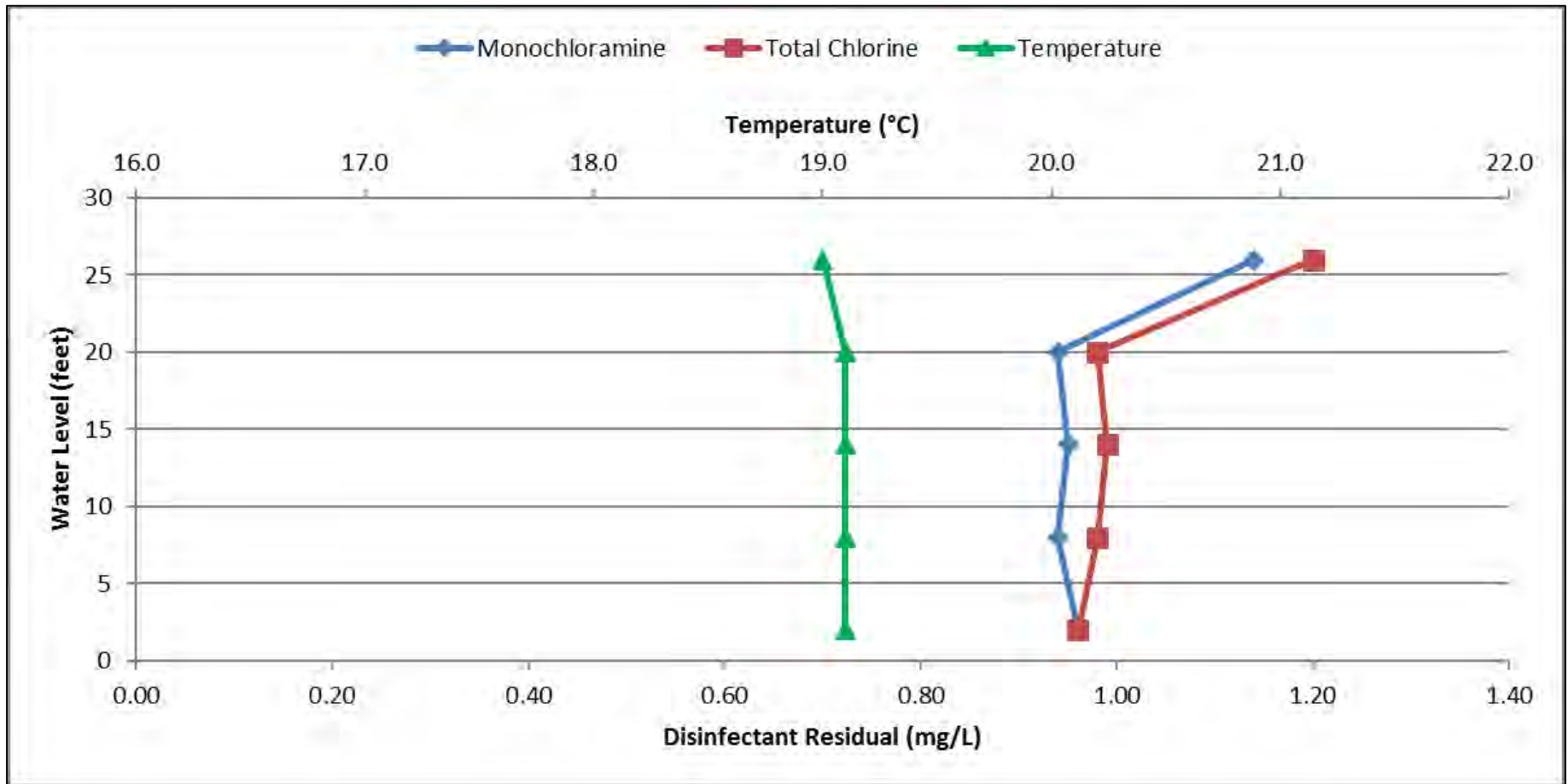
Standpipe with Mixing System



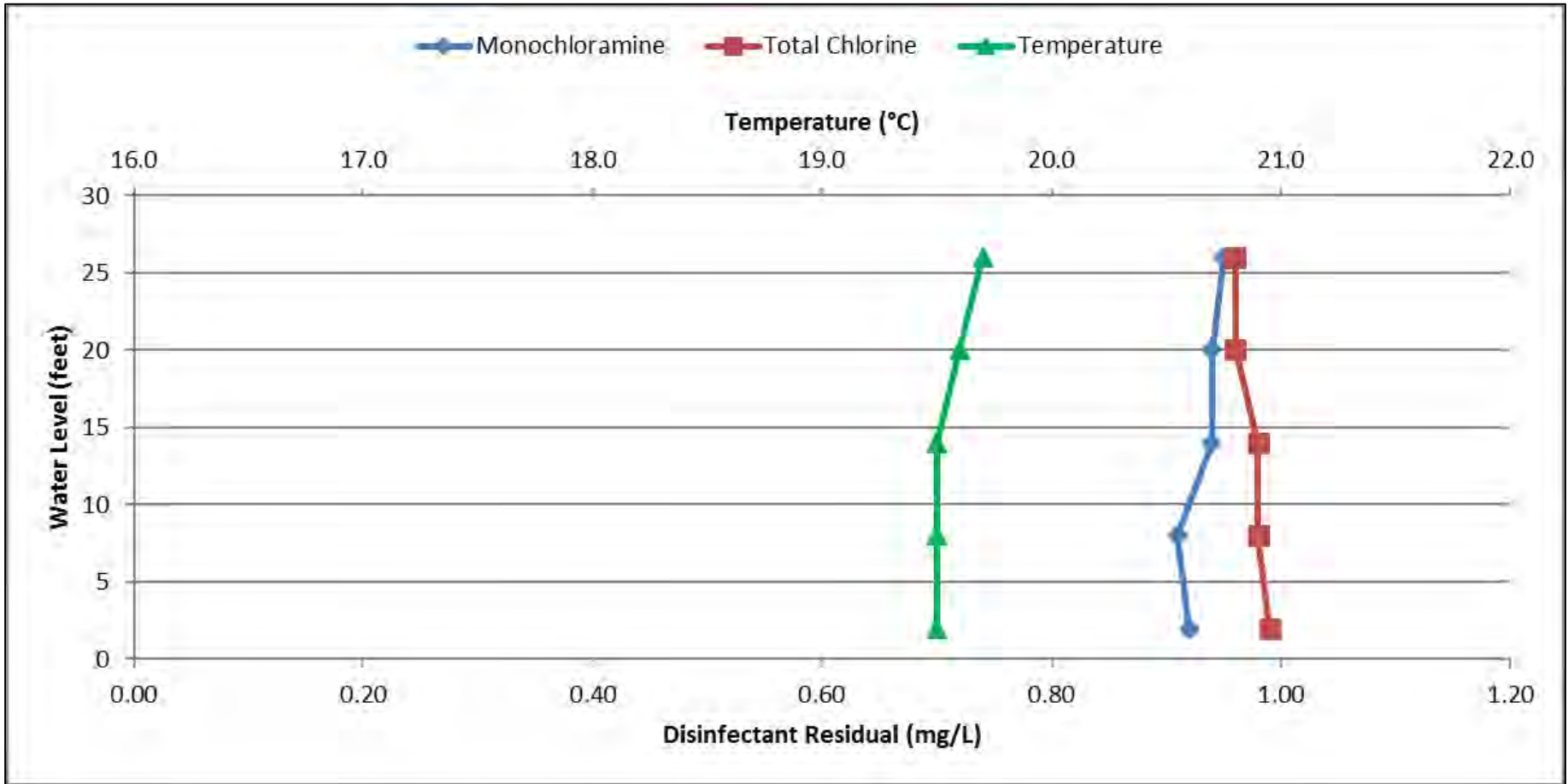
Standpipe with Mixing System



Elevated Tank with Mixing System



Elevated Tank without Mixing System



Questions?

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