Balancing Membrane Cleaning Frequency and Coagulant Dose for Columbia River Water: Pilot Study Results

Rebecca Venot/CH2M HILL
Fred Vanecek/City of Pasco
May 14, 2010

Project Timeline

- CH2M HILL selected to evaluate alternatives: July 2008
- Conceptual design completed: September 2008
- Design began: December 2008
- Equipment Purchase Bid: December 2008
- Equipment bid award to Pall: January 2009
- Construction contract out to bid: early April 2009
- **Proof pilot study: April-July 2009**
- Construction bid awarded to Apollo, Inc: May 27, 2009
- Construction began: June 2, 2009
- Plant Functional Testing: April-May 2010
- Substantial Completion: May 28, 2010
- Final Completion: June 30, 2010

Membrane Performance

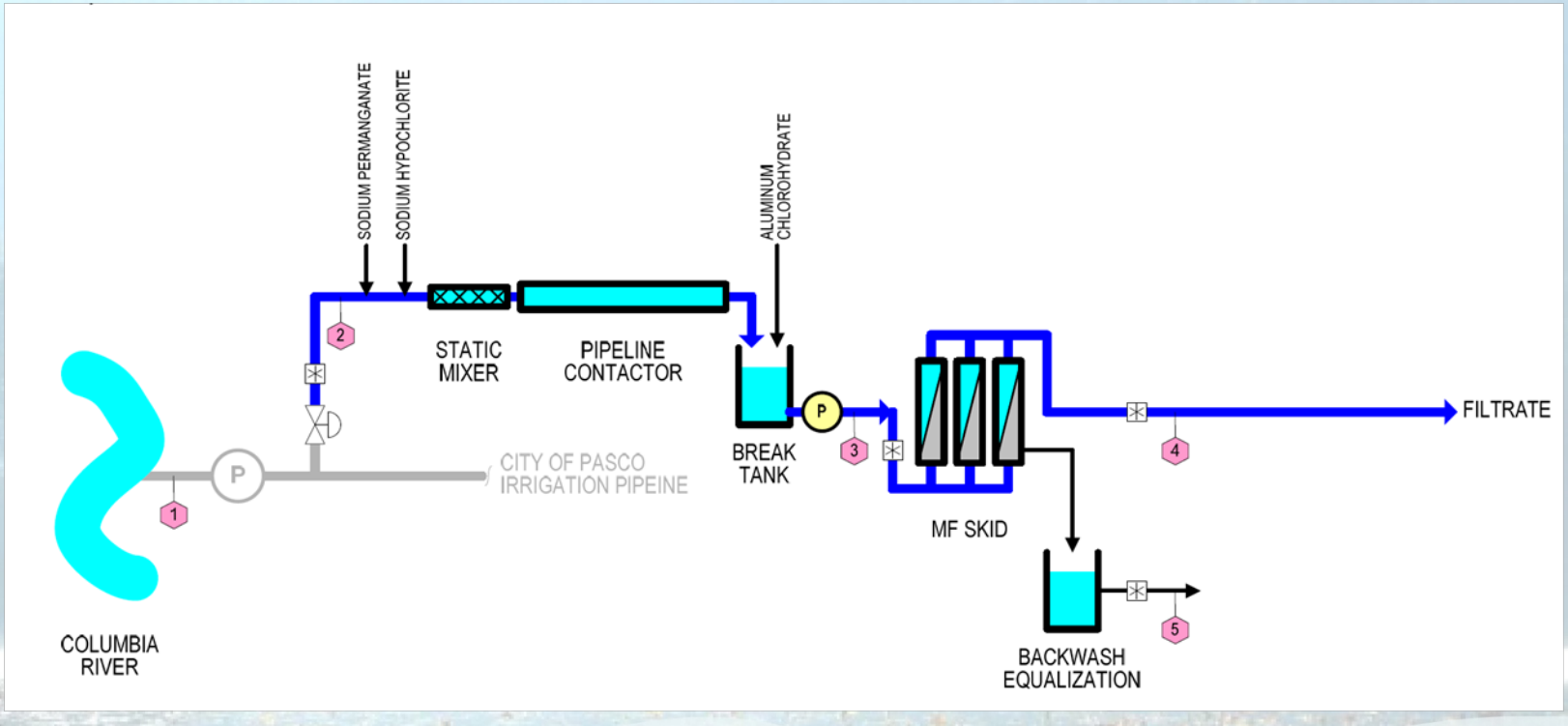
- Primary parameters
  - Permeability – basic measure of fouling
    - Temperature normalized measurement of flux per unit of TMP
  - Integrity – calculated log removal for a system
    - Measured air pressure decay rate
- Secondary parameter
  - Recovery – measure of backwash water generated to maintain an acceptable permeability

Water Quality

- Generally very good
- Low turbidity
- Low TOC
- Seasonal taste/odor events
  - 1-2 weeks in spring and fall
  - currently treated by pre-oxidation with permanganate

Temperature	°F	61.5
Turbidity	NTU	2.95
pH	--	8.06
Total Organic Carbon	mg/L	1.56
UV254	cm^{-1}	0.052
Alkalinity	mg/L	58
Hardness	mg/L	60
TSS	mg/L	6.8
Iron	mg/L	0.03
Manganese	mg/L	0.012
Aluminum	mg/L	0.03

Pilot Study Flow Diagram



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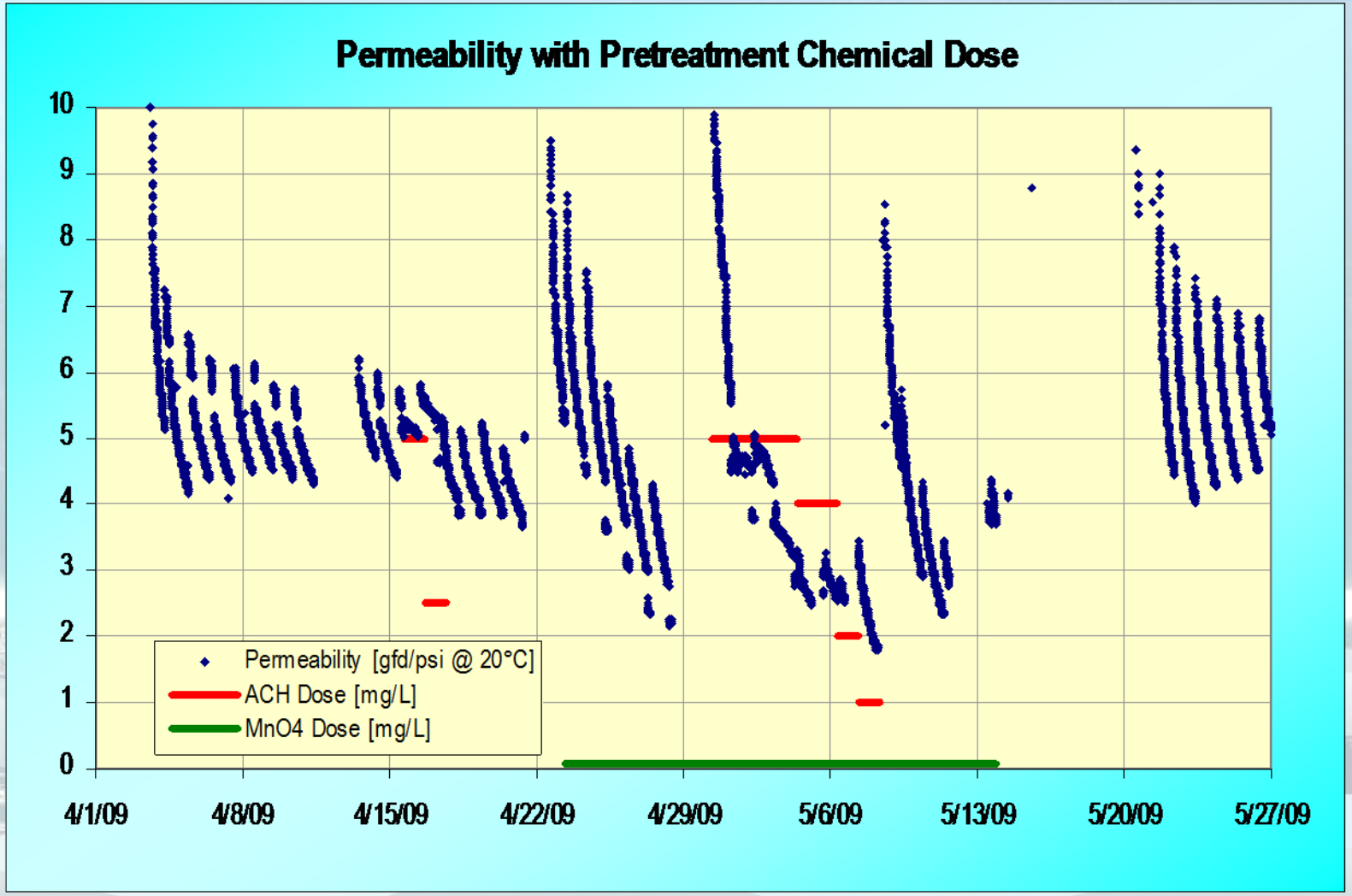
Pall Provided Pilot Skid

Pilot Study Structure

- Preliminary Testing April 3 -May 26, 2009
  - Various pretreatment chemical feed regimes and cleaning procedures
- Coagulation Optimization May 27-June 2
  - Structured test of membrane response to coagulant dose
- Confirmation Testing: June 3-July 29
  - Sustained system performance

Pilot Study Results: Preliminary Testing



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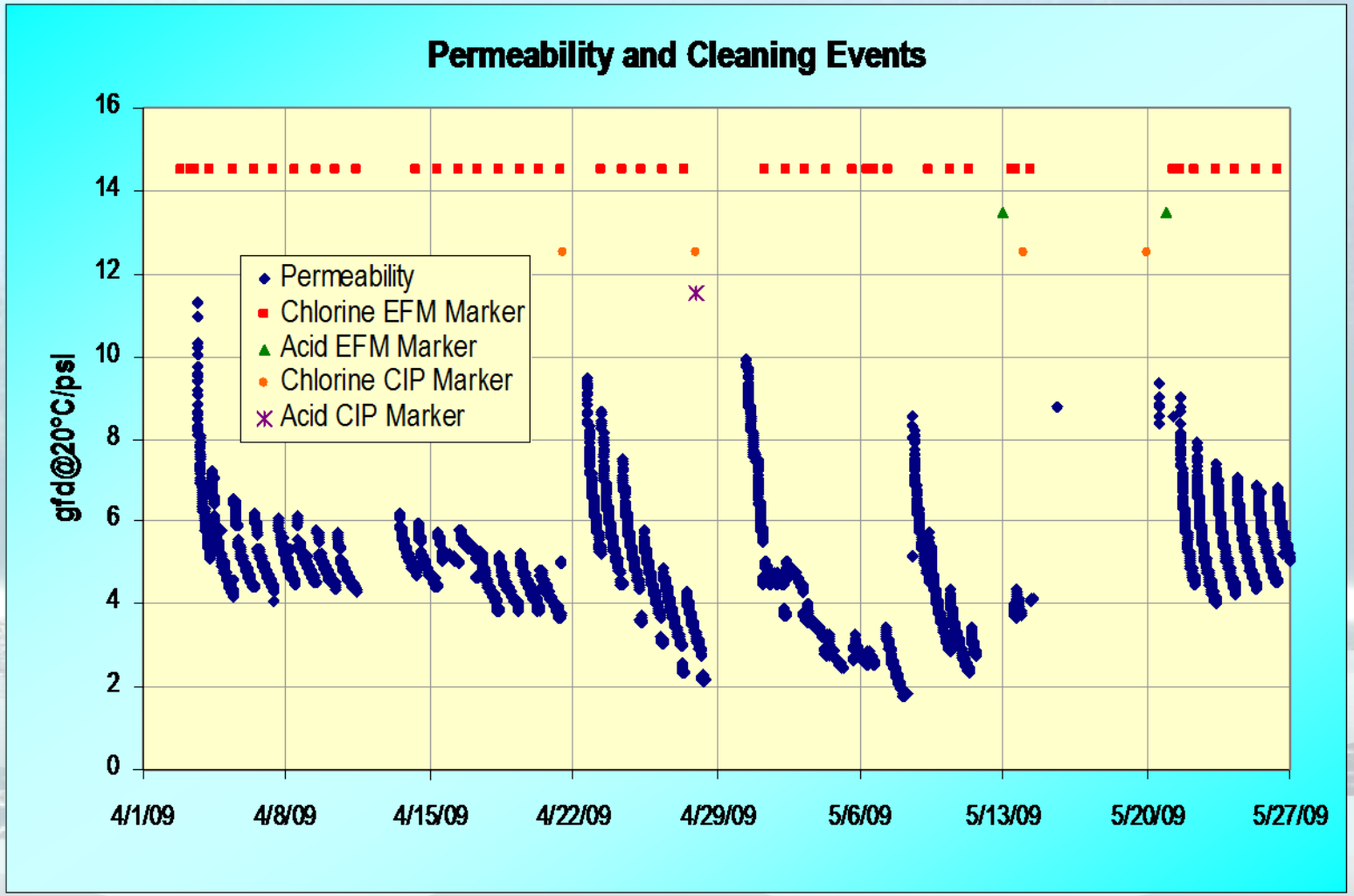
Pilot Study Results: Preliminary Testing



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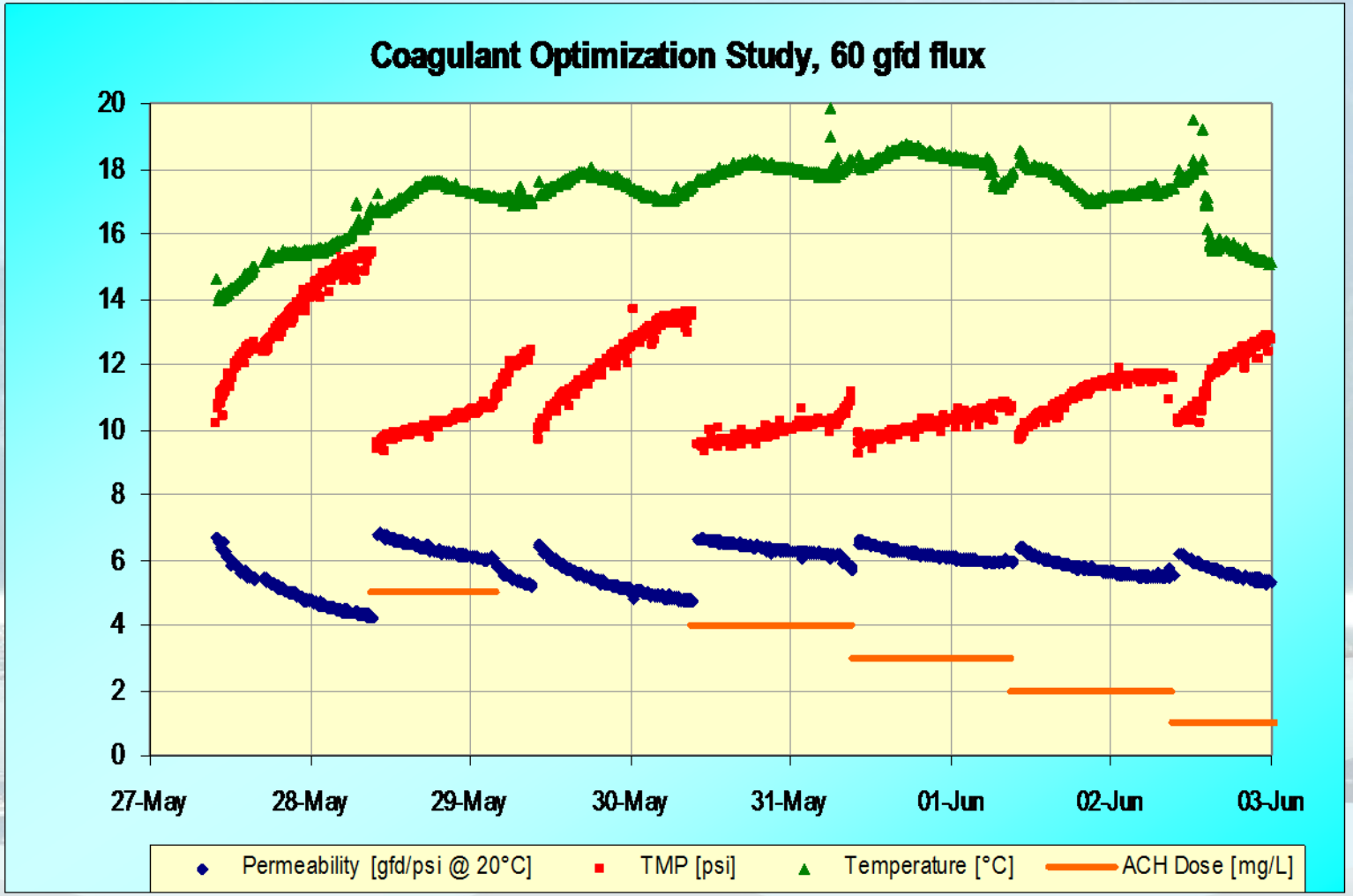
Pilot Study Results: Coagulation Optimization



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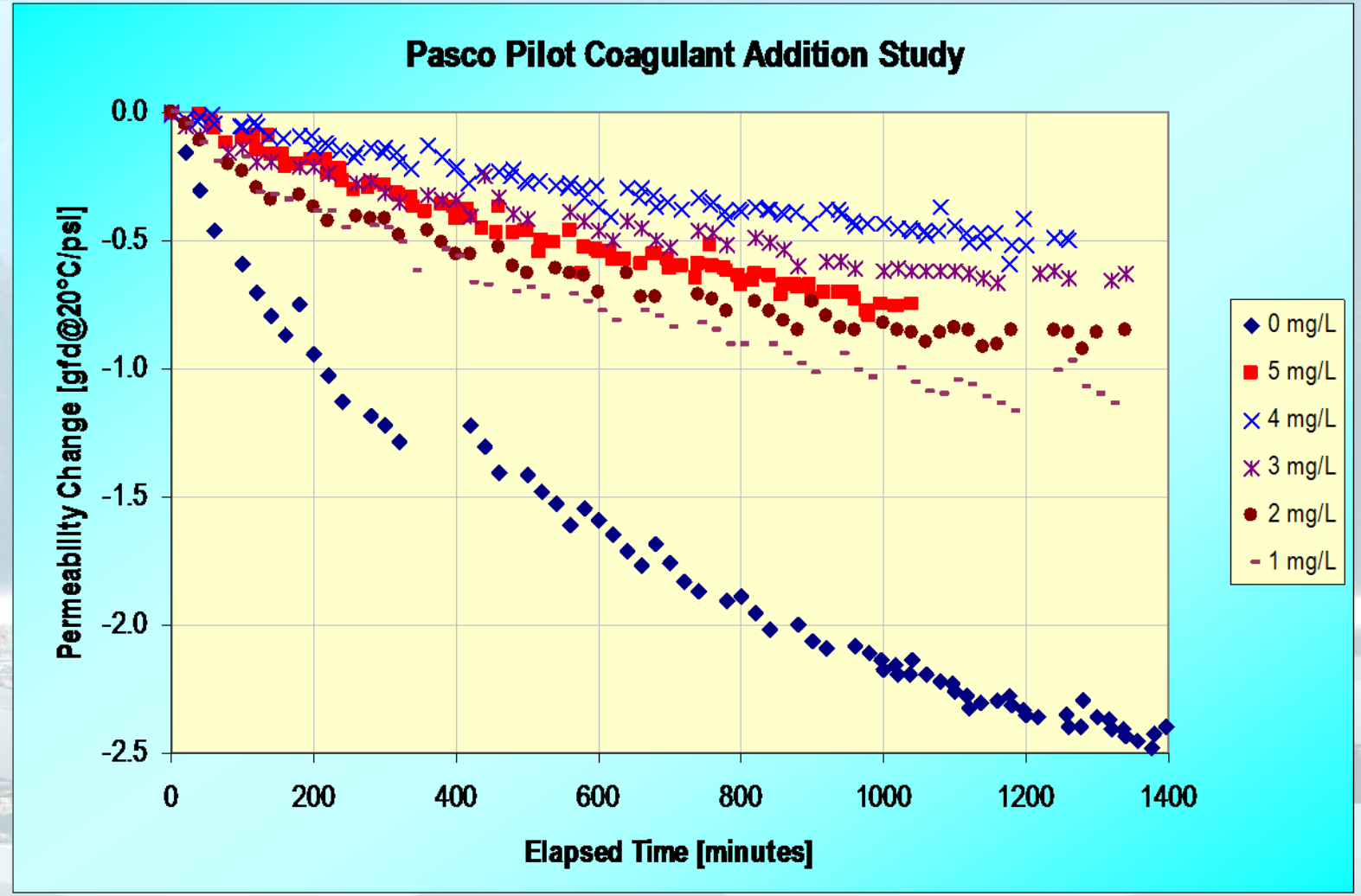
Pilot Study Results: Coagulation Optimization



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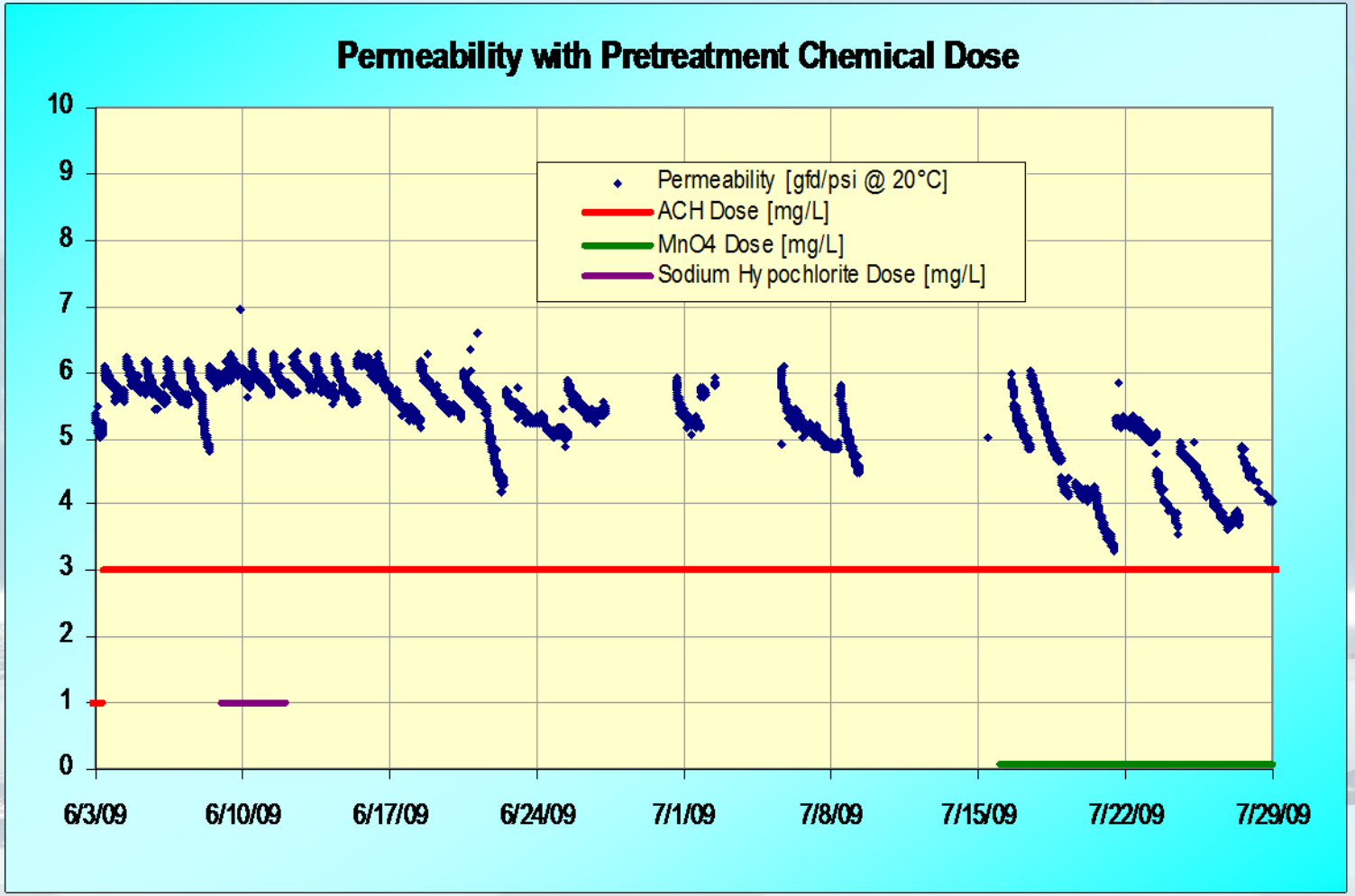
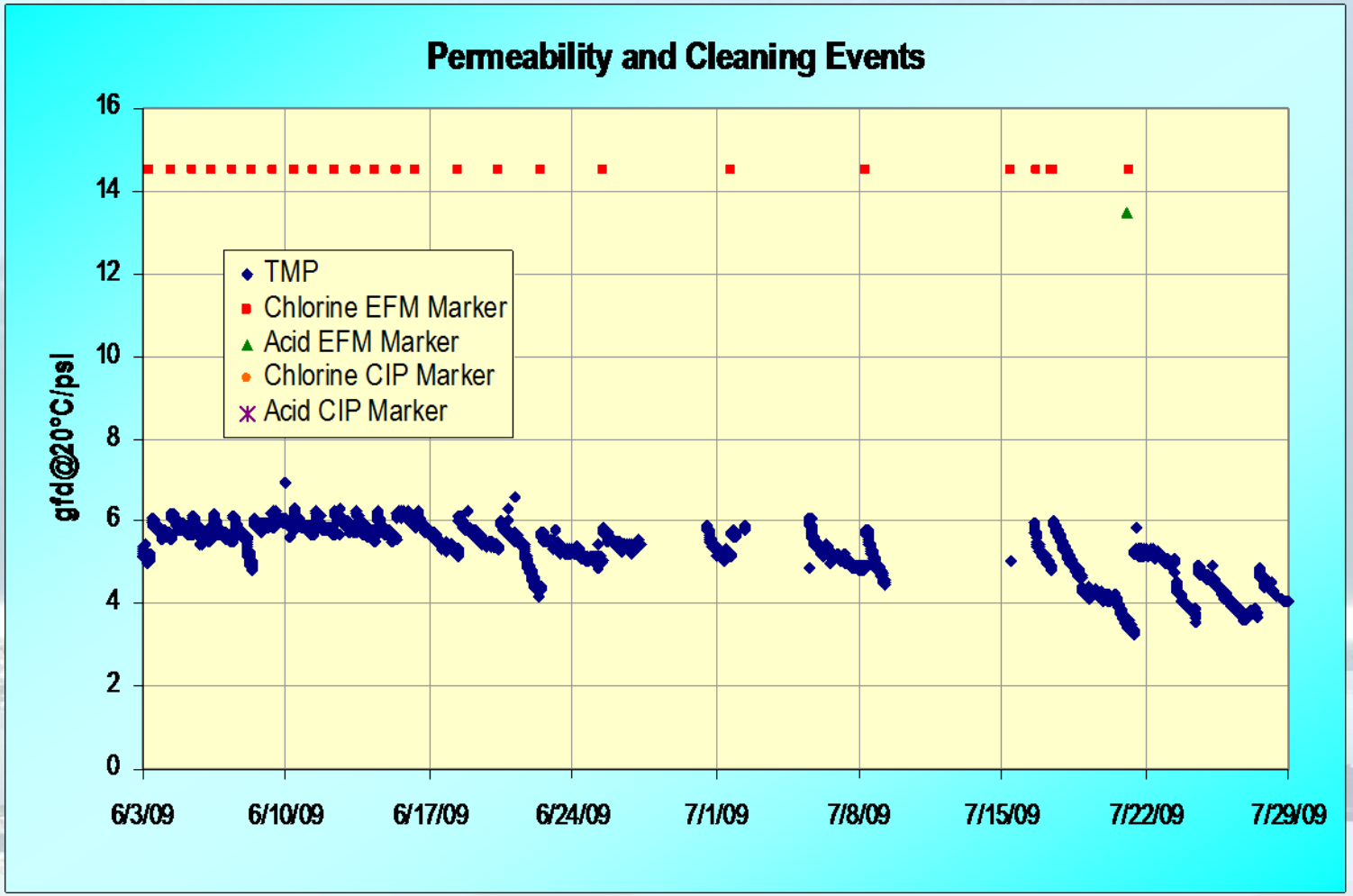
Pilot Study Results: Confirmation Testing



Membrane performance parameters during confirmation testing

Pilot Study Results: Confirmation Testing



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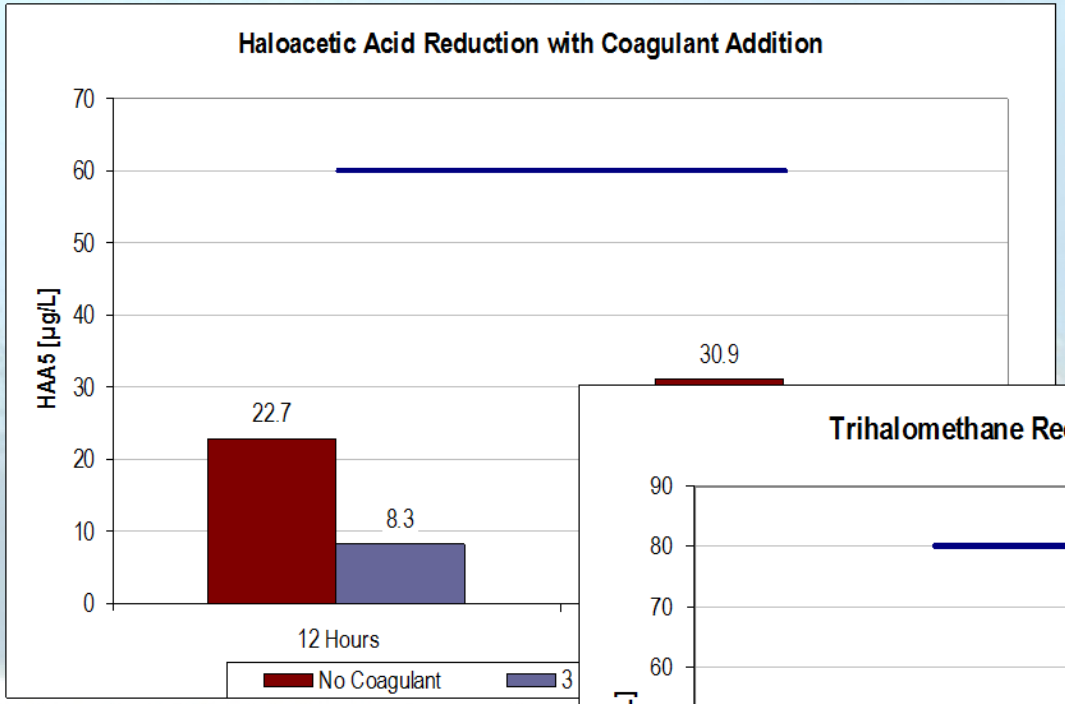
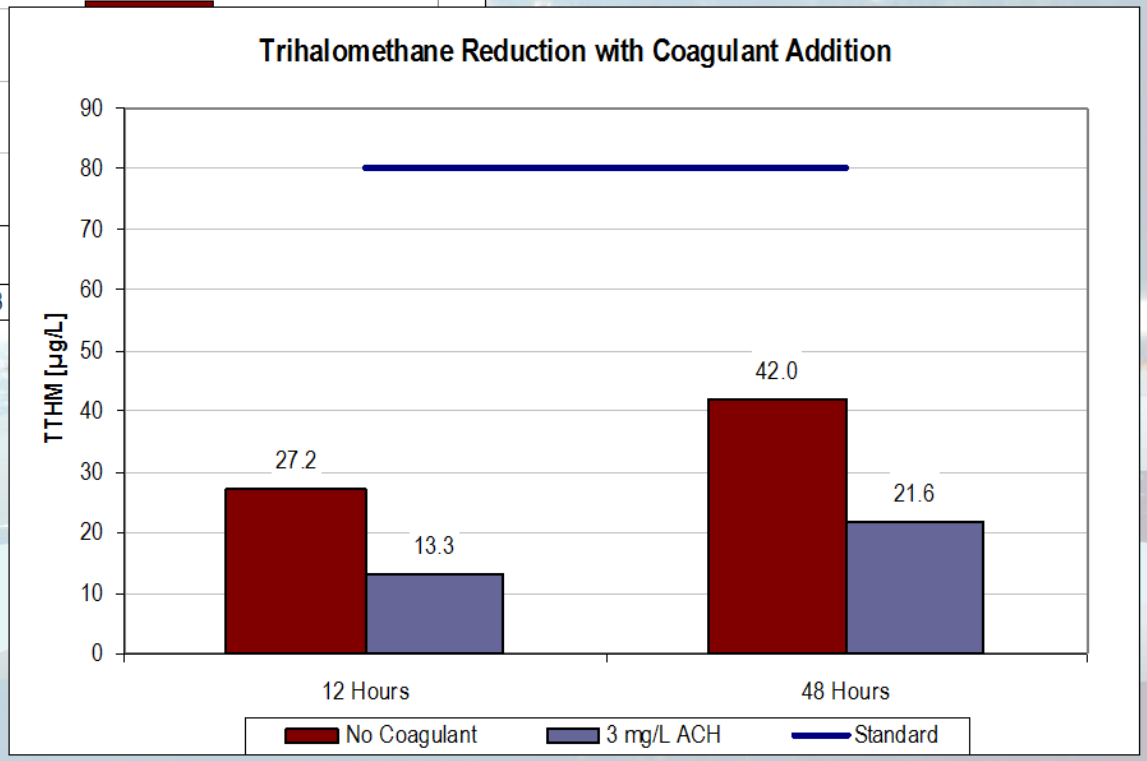
Pilot Study Results:

DBP Formation Potential – Coagulant Addition





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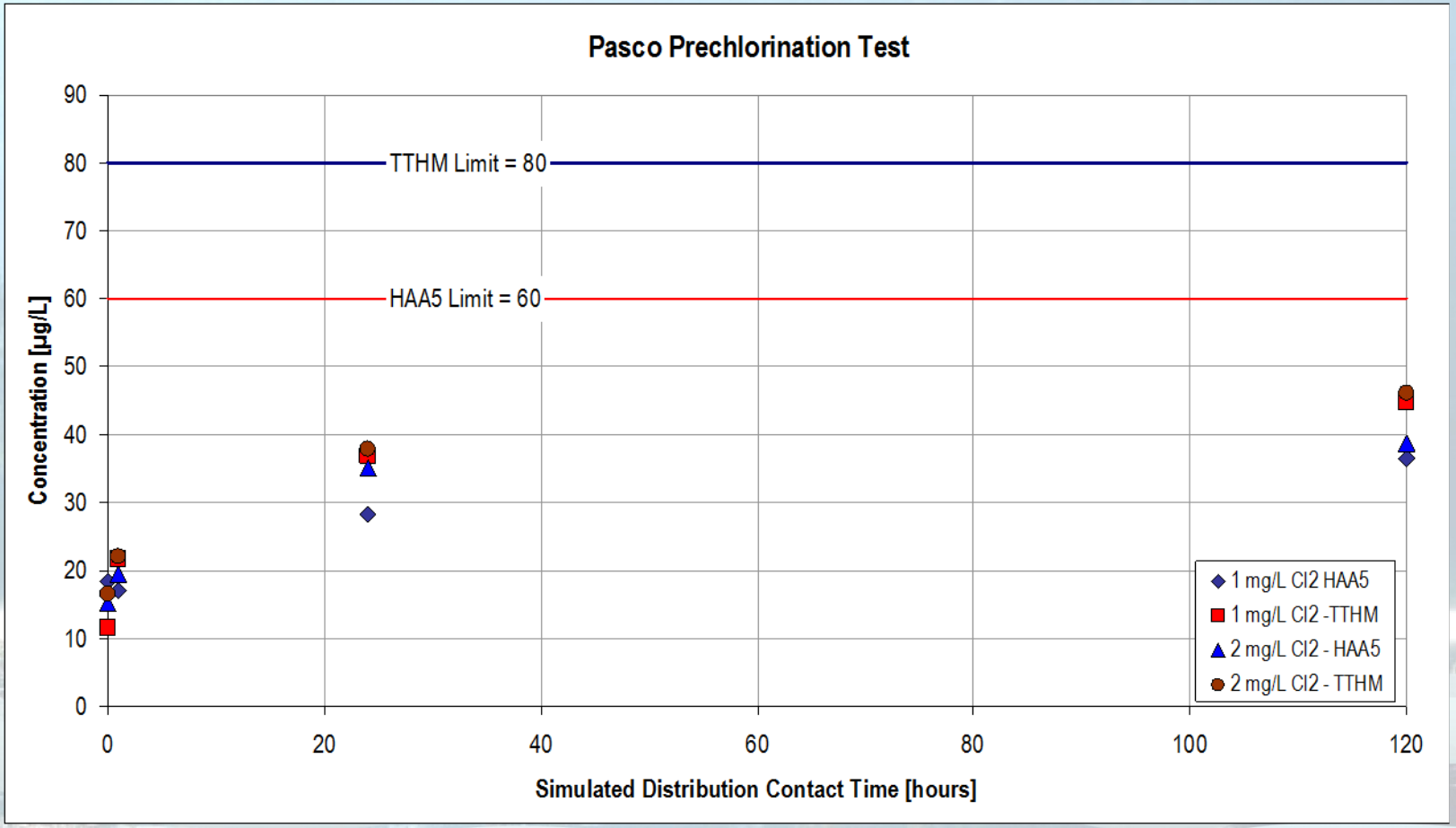
Pilot Study Results:

DBP Formation Potential – Pre-chlorination



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Pilot Study Results:

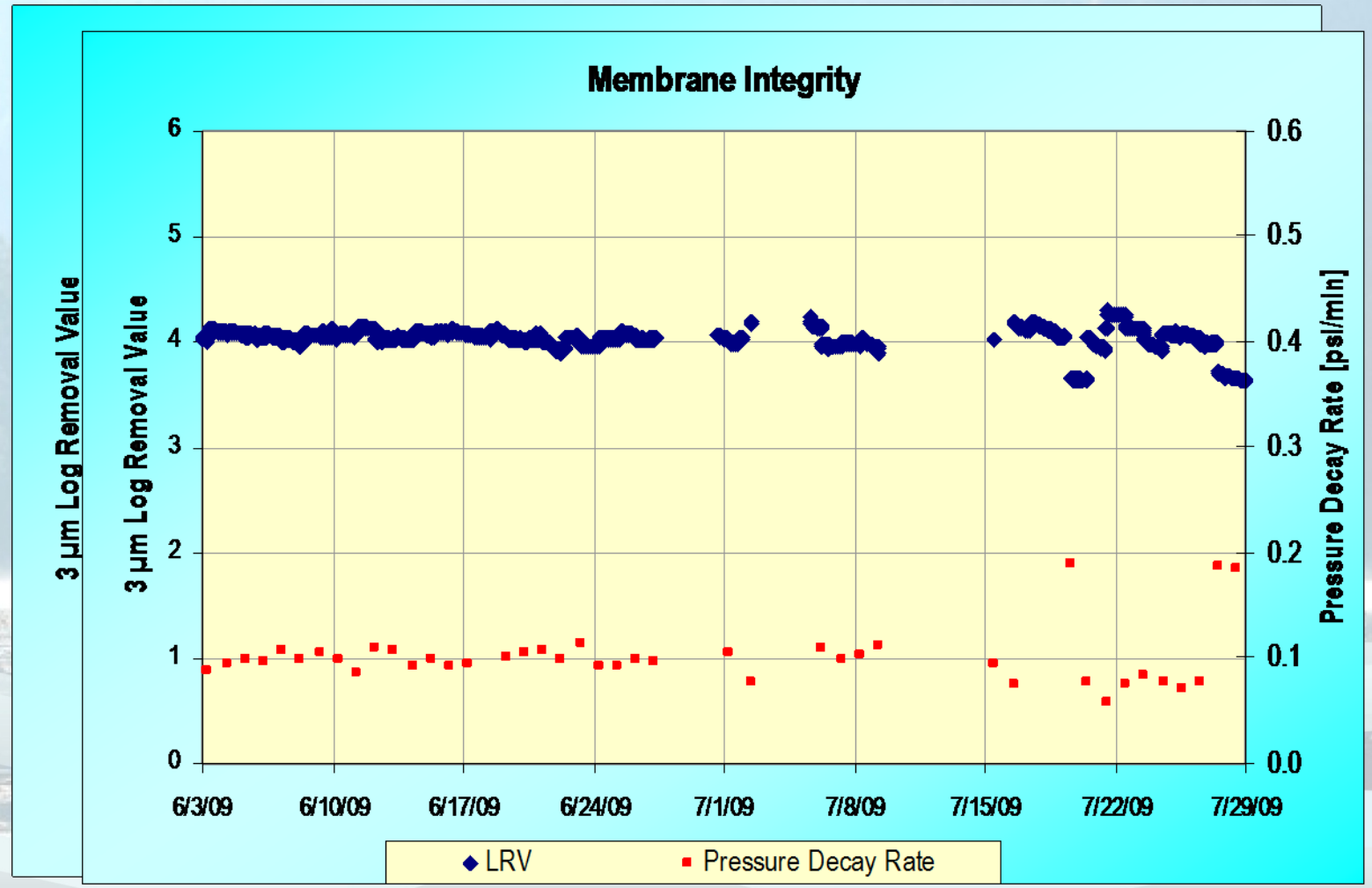
Integrity Testing

- Integrity testing is required for LT2 credit for *Cryptosporidium* removal
- Resolution – to detect 3 micron breaches
- Sensitivity – to verify pathogen log removal
- Frequency – at least daily

$$LRV_{3\mu} = 1.505 + \log\left(\frac{Q_w \cdot \mu_w}{V_H \cdot TMP}\right) + \log\left(\frac{\left(\frac{R \cdot T}{M}\right)^{0.5}\left(p_1^{\,2} - p_2^{\,2}\right)^{0.5}}{D \cdot PDR}\right) + \log\left(\frac{\frac{L}{D}}{\frac{f \cdot L}{D} + \left(\ln\left(\frac{p1}{p2}\right)^{0.5}\right)}\right)$$

Pilot Study Results:

Integrity Testing



Log removal and pressure decay rates

Pilot Study Conclusions

- The Pall system was able to meet the design criteria guaranteed in the bid documents
- Pretreatment with ACH at 3 mg/L reduces fouling by natural organic matter and reduces DBP formation potential
- Prechlorination up to 2 mg/L with ACH dosing does not negatively impact membrane performance or DBP formation

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Pilot Study Conclusions

- Pretreatment with 3 mg/L ACH allows a reduction in the frequency of EFM cleanings to every 2-3 days instead of every day to prevent membrane fouling.

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Pilot Study Conclusions

- Addition of potassium permanganate increases membrane fouling and requires more rigorous chemical cleaning to remove fouling.
  - Daily EFM cleaning alternating between standard hypochlorite and citric acid
  - CIP regime requires citric and sulfuric acid blend with extended recirculation/soaking periods

Questions?

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Current Status

- Construction Complete
- Pall on site for functional testing
- Scheduled handoff to City at end of month

Current Status

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