

CH2MHILL®

Pilot Scale vs. Full Scale

Pressure Membrane Plant Performance After Two Years of Operation



PNWS
IDAHO • OREGON • WASHINGTON

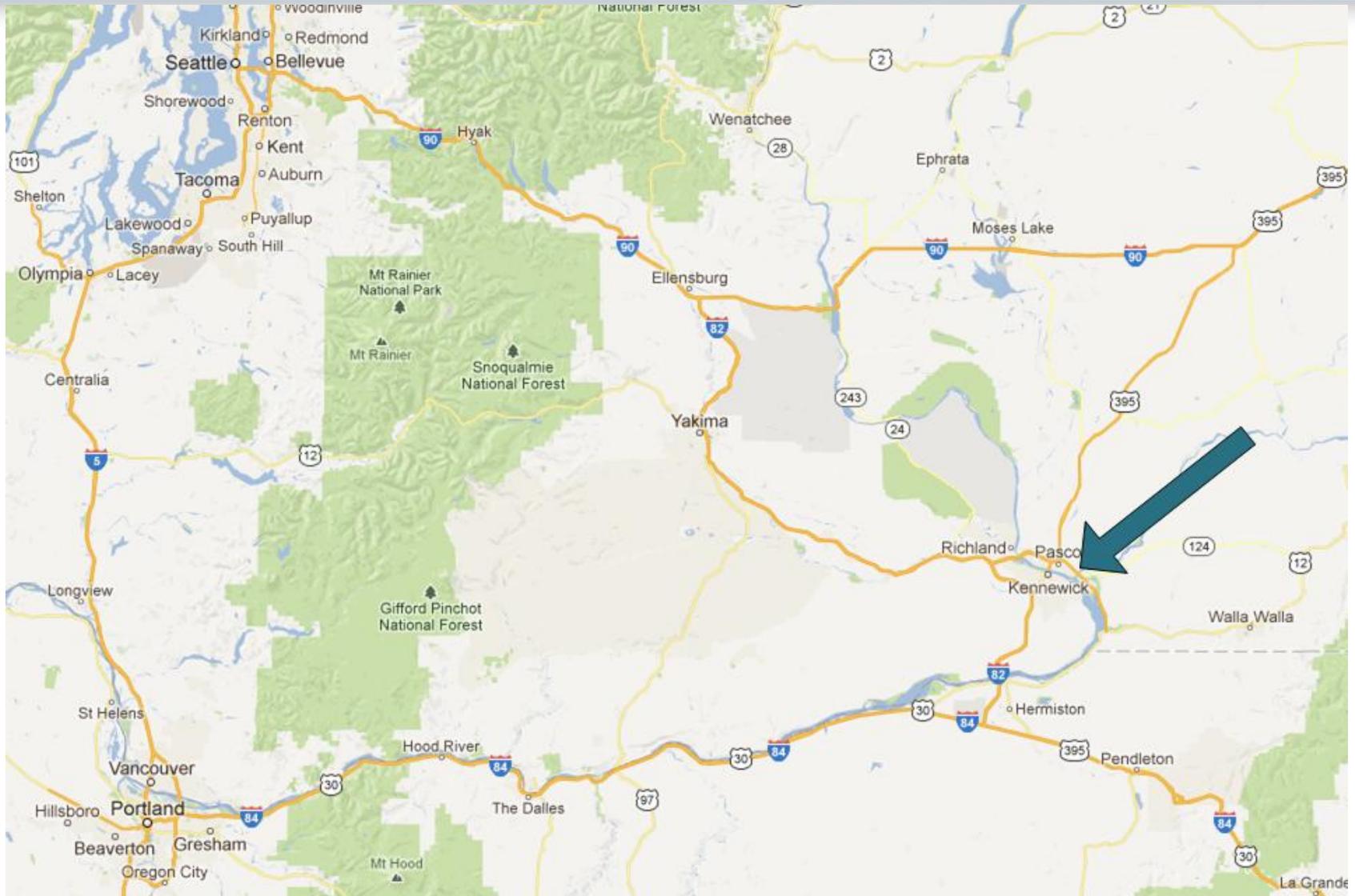


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Acknowledgements

- Coauthors
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 - Ahmad Quayoumi, PE, City of Pasco
- City of Pasco, Washington

City of Pasco, WA



Raw Water Quality

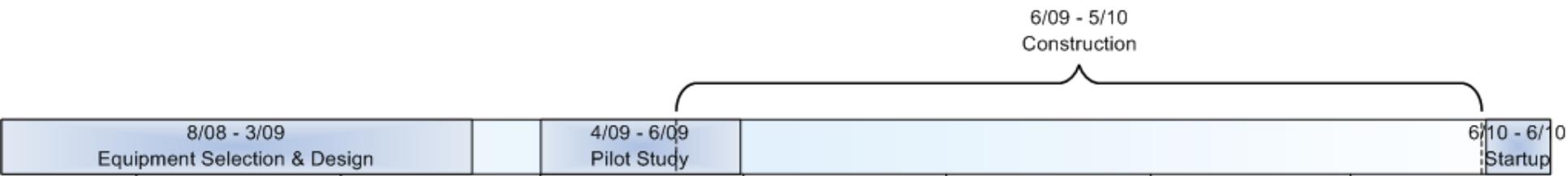
- Generally very good
- Low turbidity
- Low TOC
- Seasonal taste/odor events
 - 1-2 weeks in spring and fall
 - Treated in conventional plant by pre-oxidation with permanganate

Parameter	Unit	Value
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

Project Details

Project Included:

- Raw Water Pump Station & Transmission Line
- Treatment Plant (6 MGD)
- 1.75 MG Pre-Stressed Concrete Clearwell & Storage Reservoir
- High Service Pump
- All ancillary facilities for full expansion (18 MGD)



Membrane Selection

- Owner desired:
 - Operational flexibility
 - Highly automated
 - Minimize chemical use
 - Readily expandable
- Selected (via Owner pre-purchase):
 - direct filtration
 - pressure membranes
- Selection based on capital & operational cost



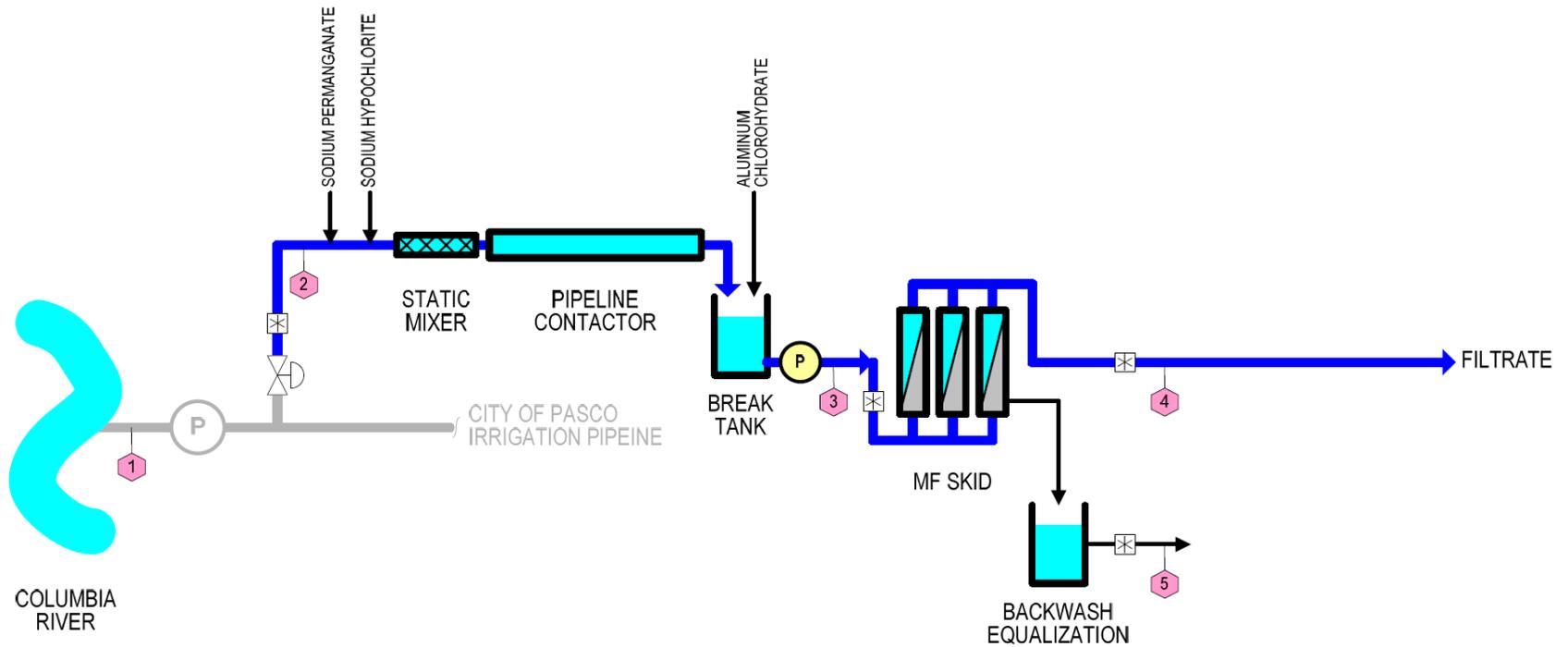
Performance Criteria

Criteria	Units	Value
Maximum Instantaneous Flux (at any temperature and feed turbidity)	gfd	60.0
Minimum System Recovery	%	95
Filtration Duration	Minutes	16.5
Air Scour/Reverse Filtration Duration	Seconds	60
Filtrate Flush Duration	Seconds	30
EFM Interval	Days	1
Cleaning Solution		500 mg/L NaOCl
Soak & Recirculation Time	Minutes	30
CIP Interval	Days	45
Cleaning Solution		2% Citric Acid 1% NaOH + 1,000 mg/L NaOCl

Proof Pilot Study Premise

- Membrane technology is proven within WA state
- City of Kennewick did piloting of very similar water quality for their membrane system in 2004.
- City and CH2M HILL worked with Washington Department of Health to allow “Proof Piloting” of selected membrane system
 - Confirms assumptions made in design
 - Verifies claims made in bid process by membrane supplier

Pilot Study Layout



Membrane Supplier Provided Trailer



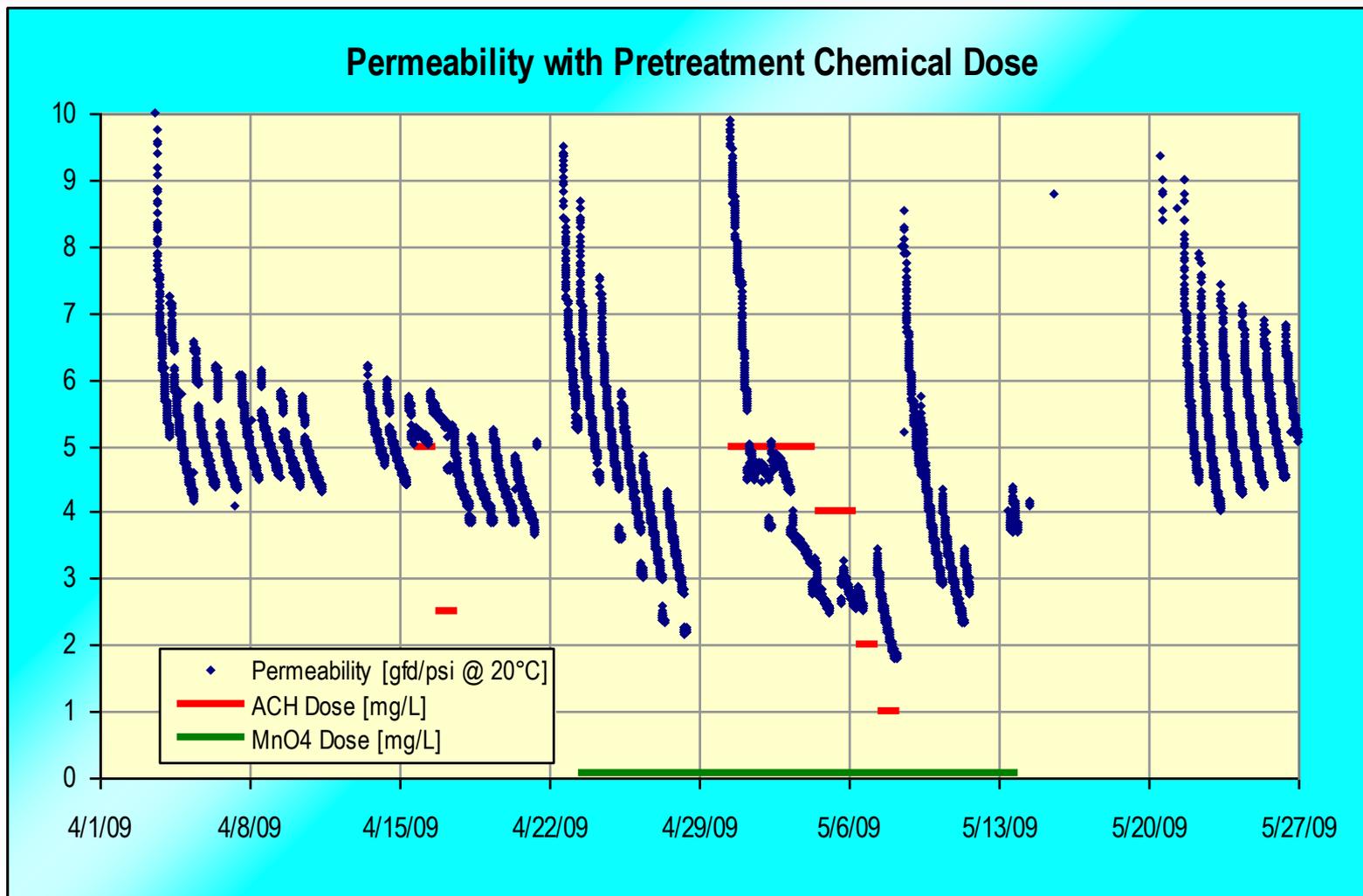
Pilot Study Phases

- 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

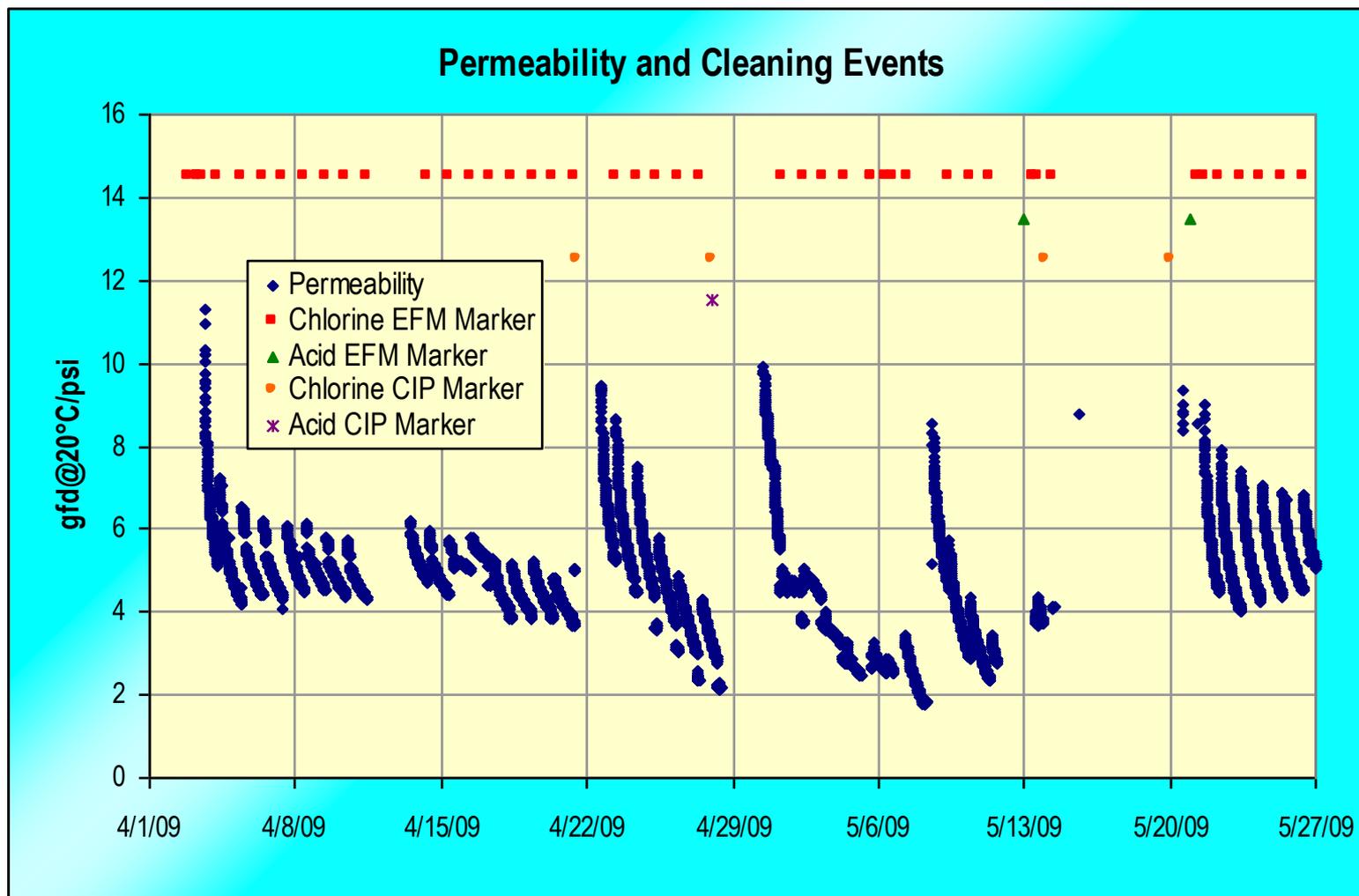
- General start-up various chemical feed regimes
- Chlorine and coagulant dosing
- Permanganate dosing for pre-oxidation study

Pilot Study Results: Preliminary Testing



Membrane performance parameters during preliminary testing

Pilot Study Results: Preliminary Testing

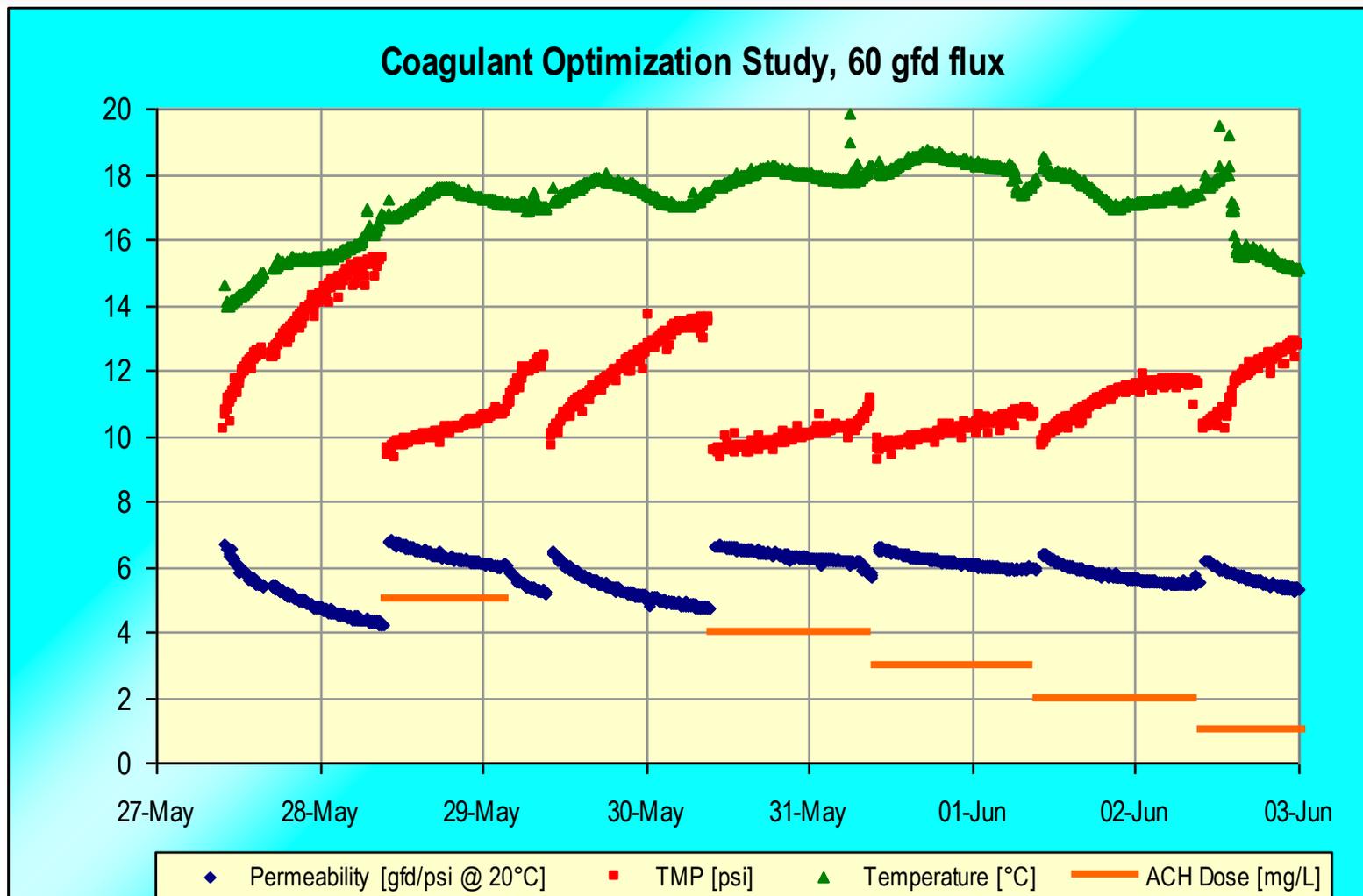


Cleaning regime used in preliminary testing

Pilot Study Results: Coagulation Optimization

- Previous experience indicated coagulant addition can help membrane performance
 - Albany-Millersburg, OR
 - Creswell, OR
 - Sandpoint, ID
 - Warrenton, WA
 - Pendleton, OR
- Dose aluminum chlorohydrate (ACH) at decreasing doses over a week
- Changed daily during each EFM

Pilot Study Results: Coagulation Optimization

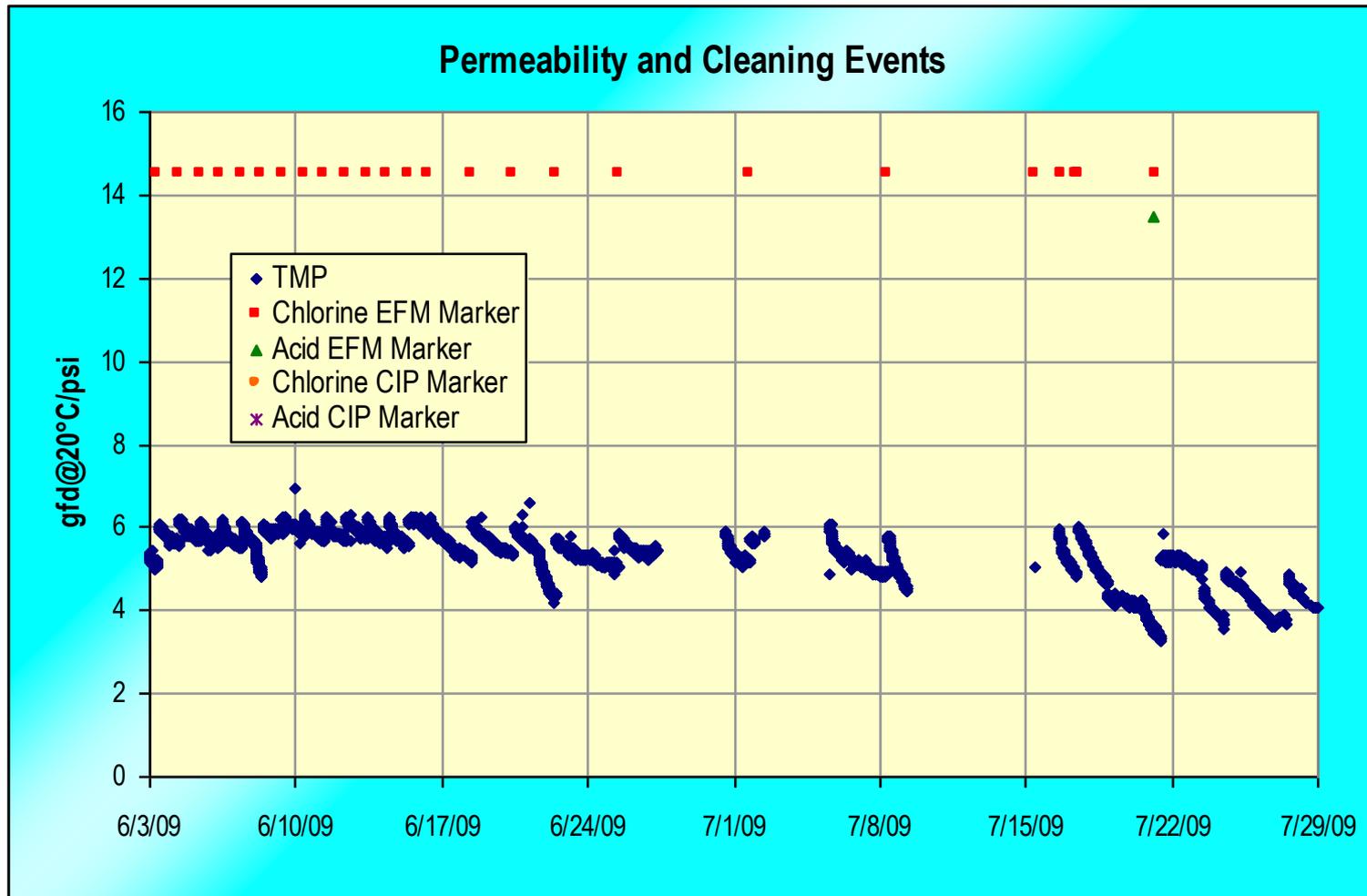


Membrane performance parameters during coagulation study

Pilot Study Results: Confirmation Testing

- Sustained membrane performance
- Additional investigation of permanganate dosing and membrane fouling

Pilot Study Results: Confirmation Testing



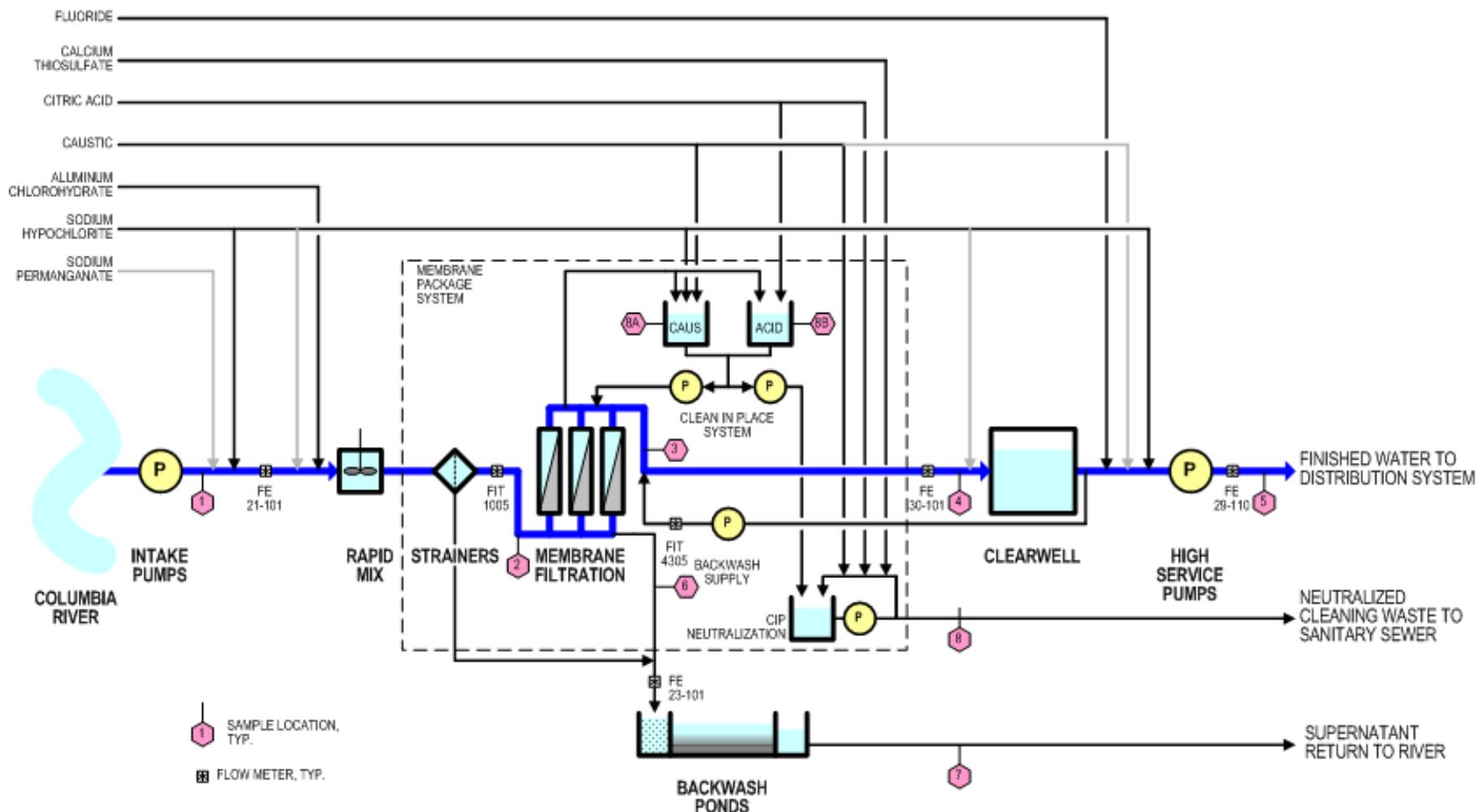
Cleaning regime used in confirmation testing

Pilot Study Conclusions

- The membrane 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 allows reduced EFM frequency
- Prechlorination up to 2 mg/L with ACH dosing does not negatively impact membrane performance
- Addition of potassium permanganate increases membrane fouling and requires more rigorous chemical cleaning to remove fouling.

Full Scale Plant Design

WEST SIDE WATER TREATMENT PLANT
PASCO, WASHINGTON
PROCESS THUMBNAIL DIAGRAM



Full Scale Plant

- Largest membrane rack built to date
 - 3 MGD per rack
 - 116 modules/rack, space for 140 modules
 - 30 feet long

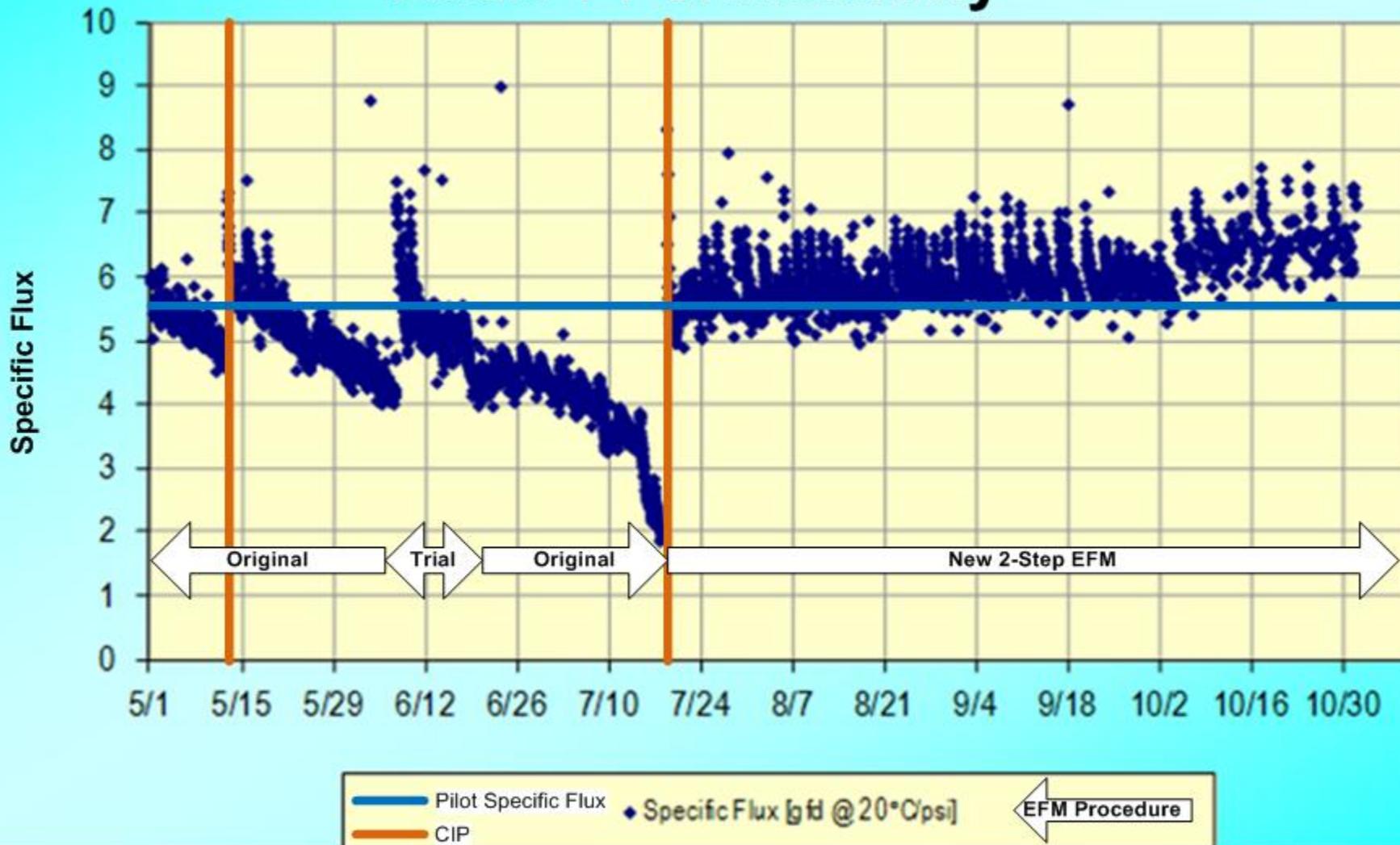


First Year of Operation Monitored Test Period

- Allowed testing of seasonal variation of coagulant dose
- Verified full scale performance of membrane system
- Test by running one rack at flow equal to design flux
 - Performance tracked by EFM cycle

First Year of Operation Monitored Test Period

Rack 1 Permeability

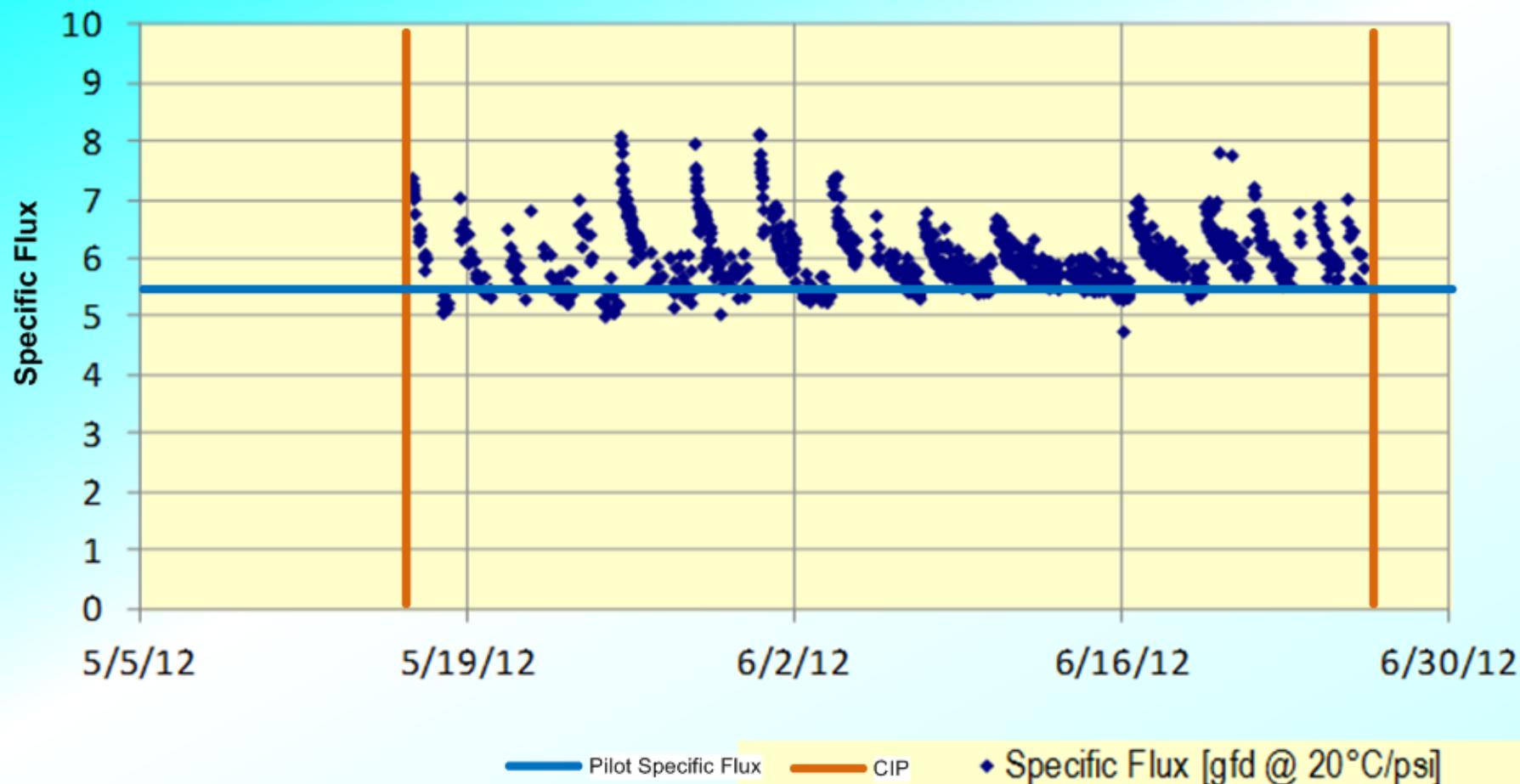


Cleaning Regime Changes

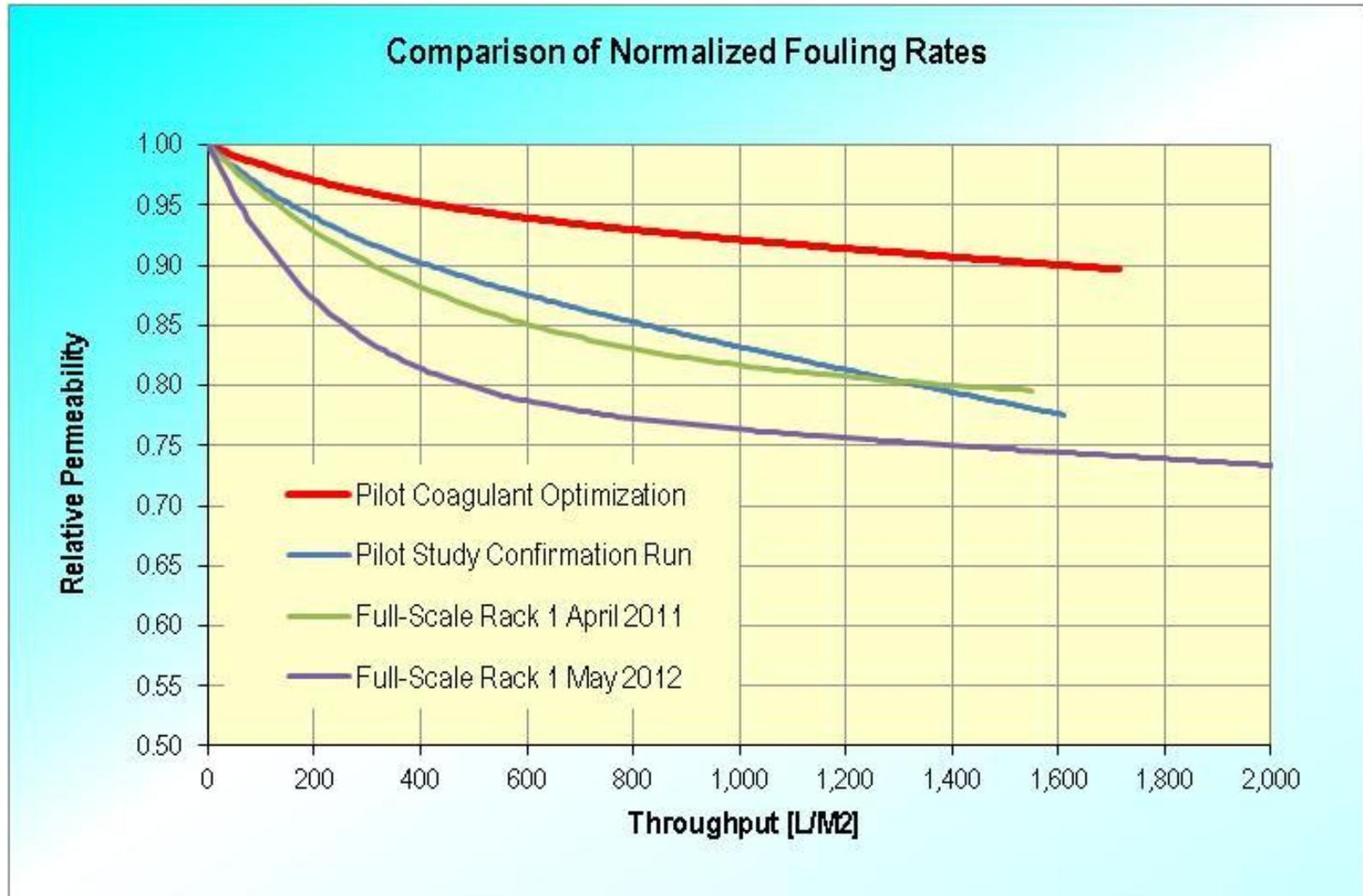
Original Regime		New Regime	
EFM			
500 ppm sodium hypochlorite	30 min wash	0.75% citric acid	30 min wash
		500 ppm sodium hypochlorite	30 min wash
CIP			
2% citric acid		2% citric acid	120 min wash
1% sodium hydroxide		10,000 ppm sodium hypochlorite	120 min wash
1,000 mg/L sodium hypochlorite			

Current Operation

Rack 1 Performance by Date - Modified Cleaning Regime



Normalized Fouling Rates



Conclusions

- Rapid fouling caused by a small amount of manganese in the raw water (0.012 mg/L)
- Manganese fouling investigated in the pilot study, but only became problematic after a full year of operation.



Conclusions

- City, CH2M HILL, and Membrane Supplier are working together to optimize the cleaning regime.



Thank You!

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