



Title 22 Filtration and Disinfection: A New Conditionally Accepted Treatment Technology Saves Over \$100 Million

WaterReuse Chapter
Sacramento, CA
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Presented by:

A. Graham Calciano, P.E., PMP Brown and Caldwell

Acknowledgements to:

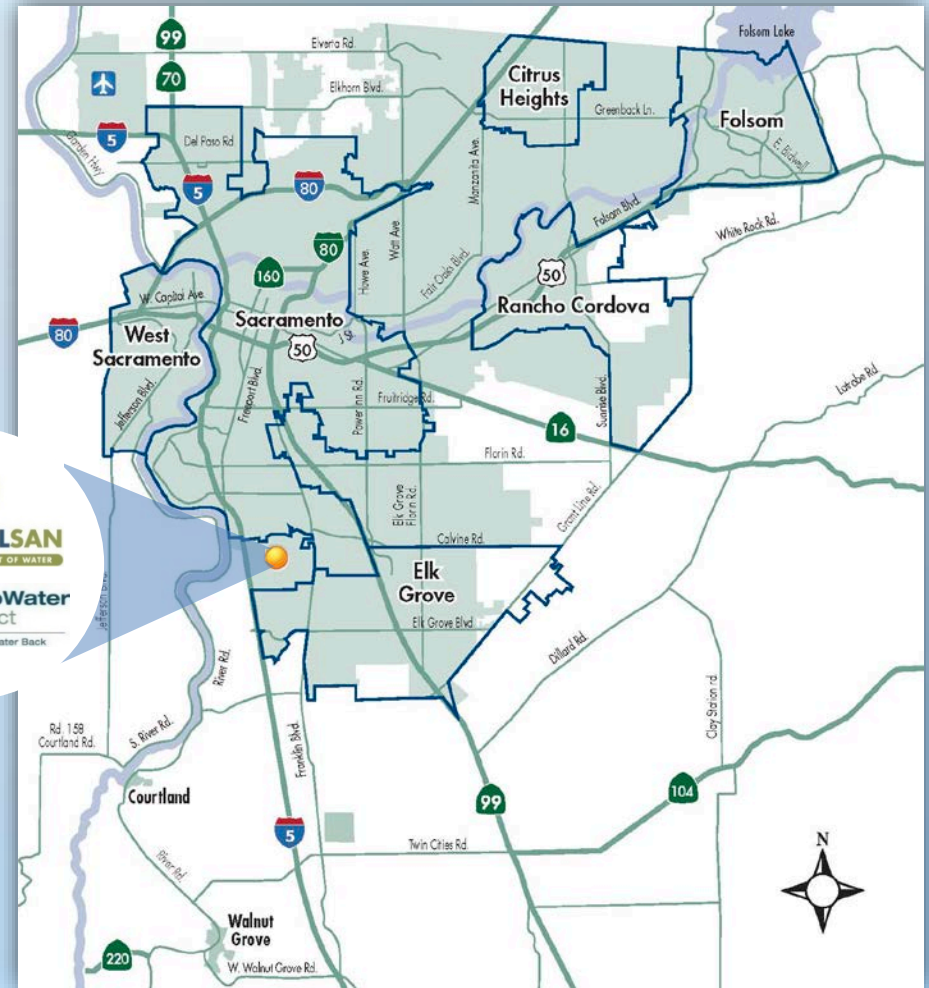
Kenneth Abraham, Rion Merlo, Bob Witzgall, Steve Ramberg, Jeremy Boyce, Mitch Maidrand, Rod Helm, William Yu, June Leng, Erin Mackey, Keith Bourgeois, Andrew Salveson, Denny Parker, George Tchobanoglous, and others

Outline

- **Introduction**
- Objectives/Efforts to Date
- Pilot Facility Overview
- Testing Protocols and Results
- Saving of Over \$100 Million
- Applicability to Other Facilities

Sacramento Regional Wastewater Treatment Plant

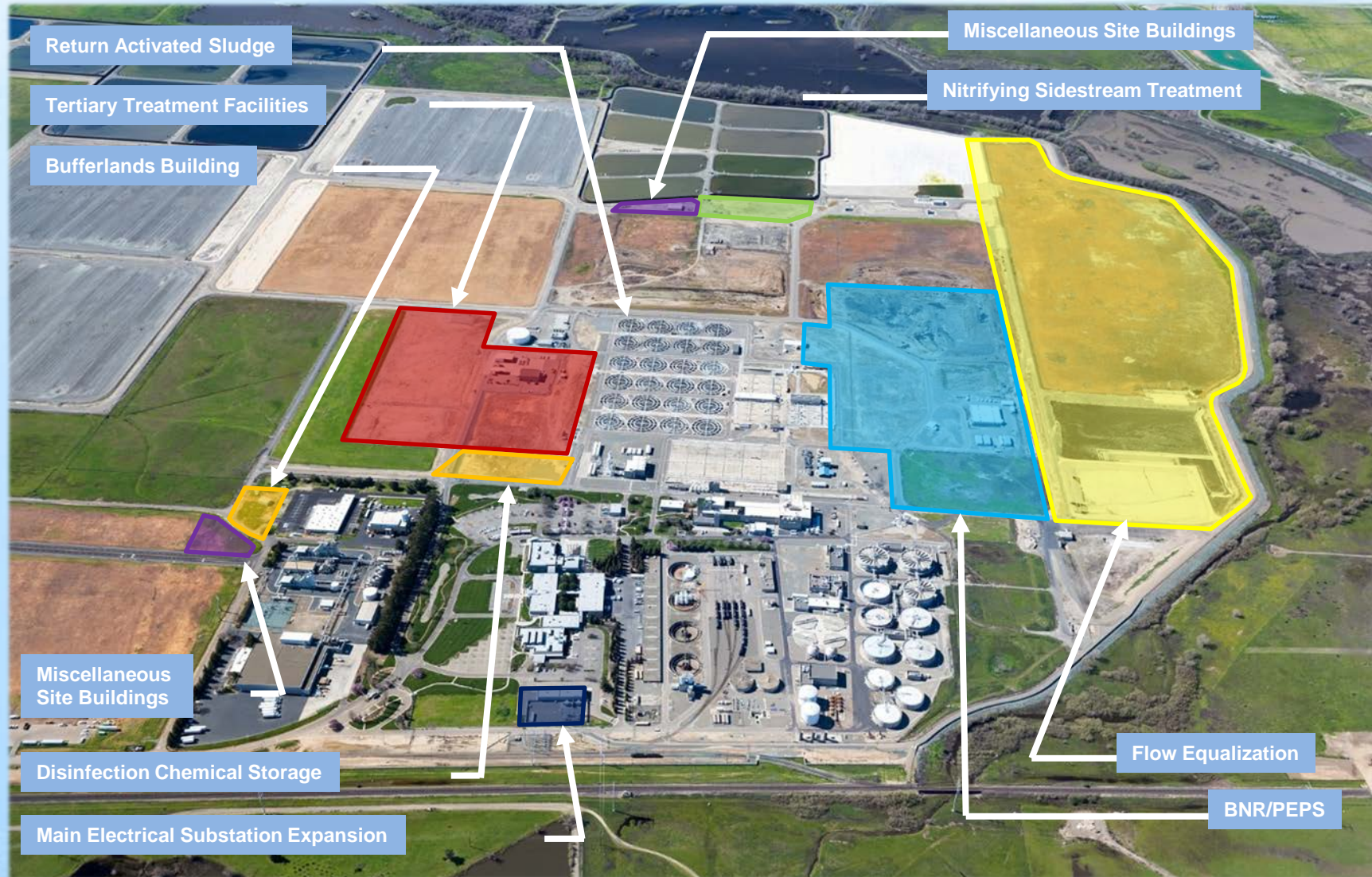
- It serves approximately 1.4 million residents over 383 square miles in the greater Sacramento Region (Residential, Industrial, and Commercial)
- 111 miles of gravity interceptor
- 58 miles of force mains
- 181 MGD (Dry Weather)
- 217 MGD (Peak Dry Weather)
- 330 MGD (Equalized Max Daily)



Project Driver - NPDES Permit

- NPDES Permit issued by Central Valley Regional Water Quality Control Board on December 9, 2010
- Required significantly higher treatment to remove ammonia, nitrates, and further reduce pathogens in the treated water.
- Replacement of pure oxygen activated sludge process with BNR process and California Title 22 filtration/disinfection
- Estimated in range of \$1.5 to \$2.1 billion, with additional annual maintenance costs
- The EchoWater Project consists of over 20 discrete projects ranging in size from \$1 million to \$414 million in construction costs
- The compliance dates are May 2021 for nutrient removal and May 2023 for Title 22 facilities

Overview of EchoWater Project



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Objectives of the Demonstration Program

- Demonstrate Title 22 Equivalency
- Achieve a Conditionally Accepted Treatment Technology (CATT) status for the Regional San technology
- Demonstration is done on a specific wastewater source

Efforts to Date

- Draft Protocol Submitted for Department of Drinking Water (DDW) Review in April 2014
- DDW Drinking Water Program Recycled Water Committee met May 8, 2014 and provided comments to draft protocol
- Regional San issued final draft for Alternative Technology Demonstration testing on Sept 23, 2014
- Demonstration test was conducted from August 2014 through October 2014
- Submitted Final Conditionally Accepted Treatment Technology (CATT) Report in June 2015

Efforts to Date

- Received Official CATT Acceptance Letter from DDW on October 12, 2015
- Title 22 Report for the Production Distribution, and Use of Recycled Water, February 2017
- Revised Title 22 Report for the Production Distribution, and Use of Recycled Water, February 2018



How Long Can It Take?

- Draft Protocol Submitted (April 2014) to ...
- Received CATT Acceptance Letter from DDW October 2015
- 18 months
- Pilot takes time to design and build

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Pilot Aerial

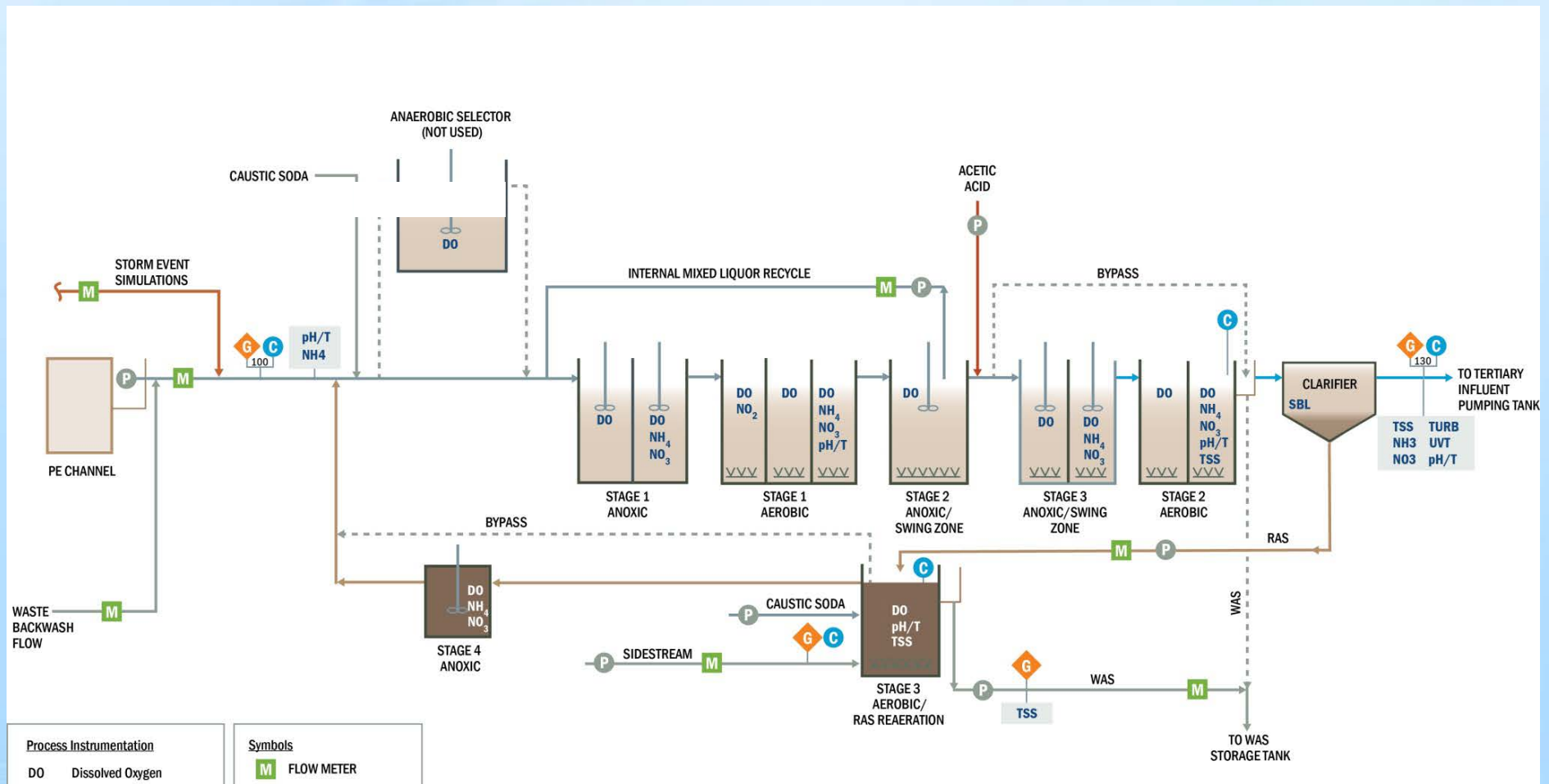


Advanced Treatment Technology Pilot

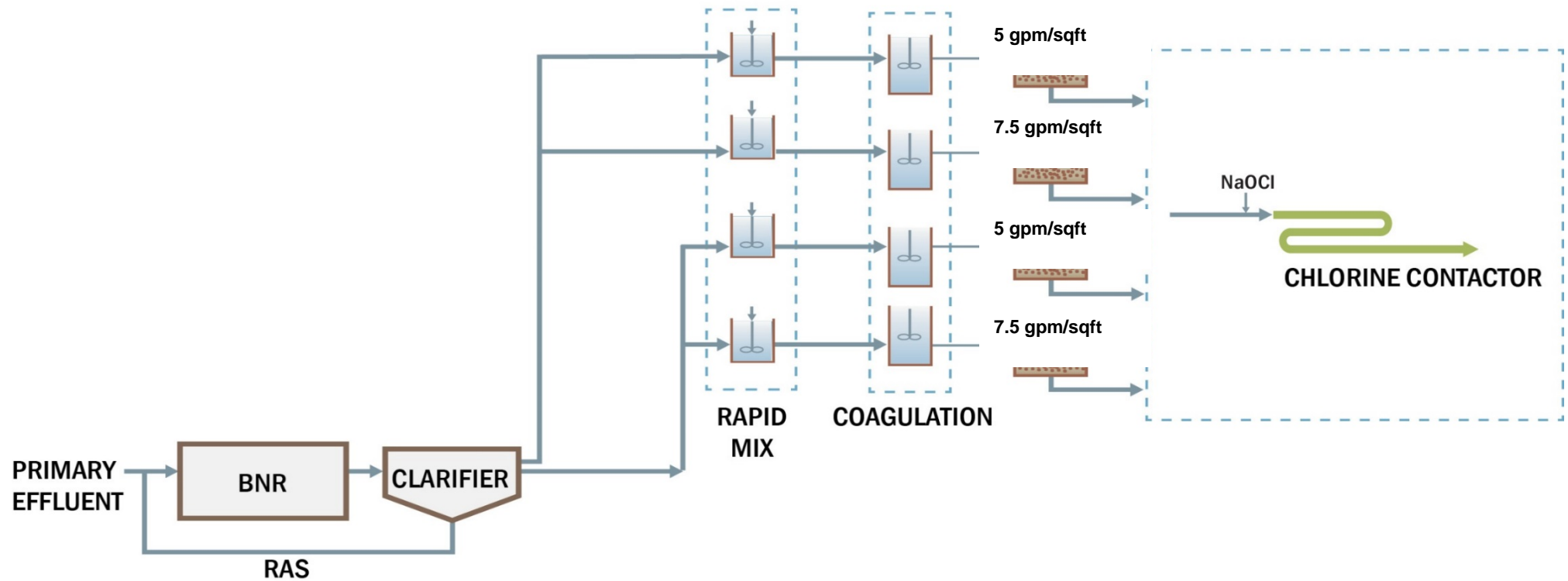
- Sufficient scale (0.25 MGD Average Flow to 0.5 MGD Maximum Capacity)
- Operated by licensed wastewater operators
- Complete SCADA system
- Pilot influent mimics main plant influent flow
- Filters operated at 5 and 7.5 gpm/ft²
- Chlorine contactor operated at constant flow of 13.6 gpm with online control of chlorine residual



Pilot Flow Schematic (BNR)



Tertiary Treatment Schematic



Granular Media Filtration



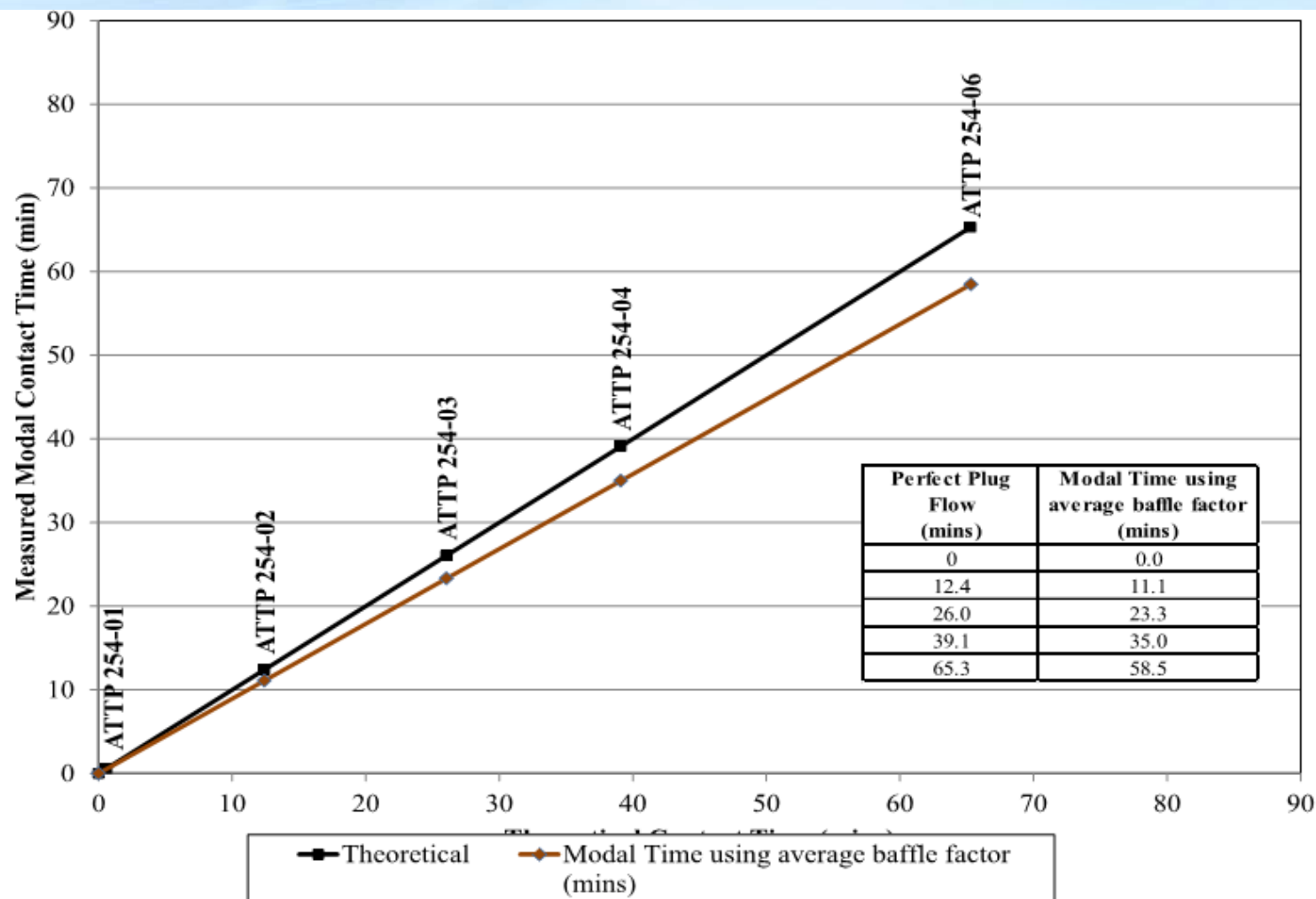
- Each filter 2 ft diameter
- 4 ft of anthracite, 1 ft of sand
- Operate at constant head (8') with a backwash initiated at 10'
- Typical 97 percent recovery

Chlorine Contactor



- 200' length serpentine reactor
- Maximum 120 minute modal contact time
- Multiple taps to test from

Modal Contact Time



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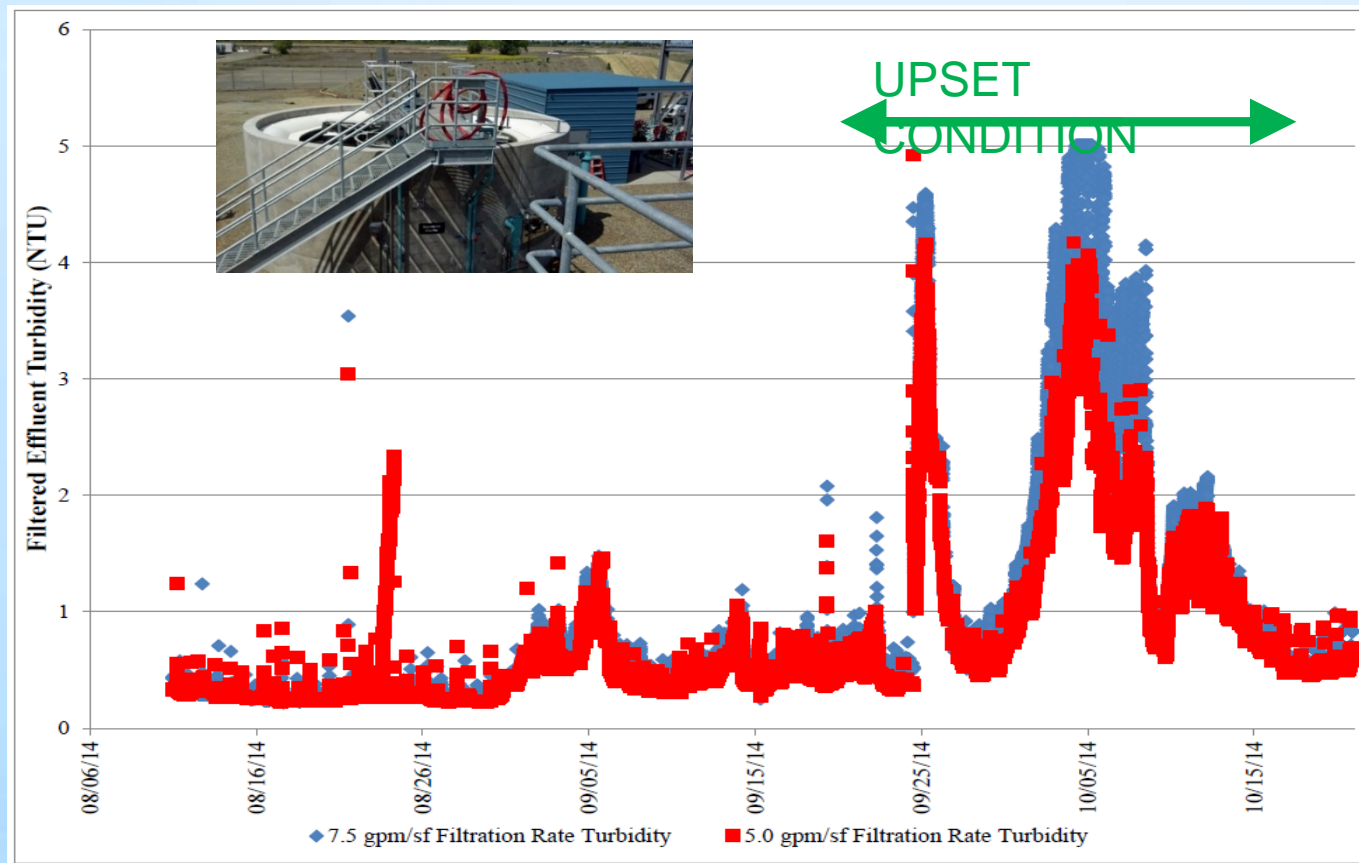
Summary of Demonstration Program

Use the pilot to demonstrate DDW Title 22 Equivalency.

- Filter Performance
 - Continuous operation of the granular media filter units at a rate 5 and 7.5 gpm/ft² in a dual/mixed media gravity filtration system
 - §60301.320 filtered wastewater requirements for turbidity.
 - An average of 2 NTU within a 24-hour period;
 - 5 NTU more than 5 percent of the time within a 24-hour period; and
 - 10 NTU at any time.
- Stated requirements vs. real requirements

Summary of Demonstration Program

Filtered Effluent Turbidity operating at 5 and 7.5 gpm/sf



Summary of Demonstration Program

Continuous Filtered Effluent Turbidity Statistics at 5 and 7.5 gpm/sf

	Filtration at 5 gpm/sf	Filtration at 7.5 gpm/sf
Sample Count	20,699	20,699
Average	0.78	0.95
Minimum	0.22	0.22
Maximum	4.92	5.01
Median	0.51	0.59
Standard Deviation	0.73	1.01
95 Percentile	2.39	3.53
5 Percentile	0.24	0.25



Summary of Demonstration Program

Use the pilot to demonstrate DDW Title 22 Equivalency.

- Disinfection with Free Chlorine
 - 5-log virus reduction
 - Total coliform limits
 - 2.2 MPN/100 mL, as a median of the last 7 days;
 - 23 MPN/100 mL, in more than one sample in any 30-day period;
 - 240 MPN/100 mL, at any time.

Demonstration Testing Plan – Virus Challenge

- Each week (8/12/14 through 10/21/14)
- MS2 solution injected into the filtered effluent upstream of the chlorine dosing location



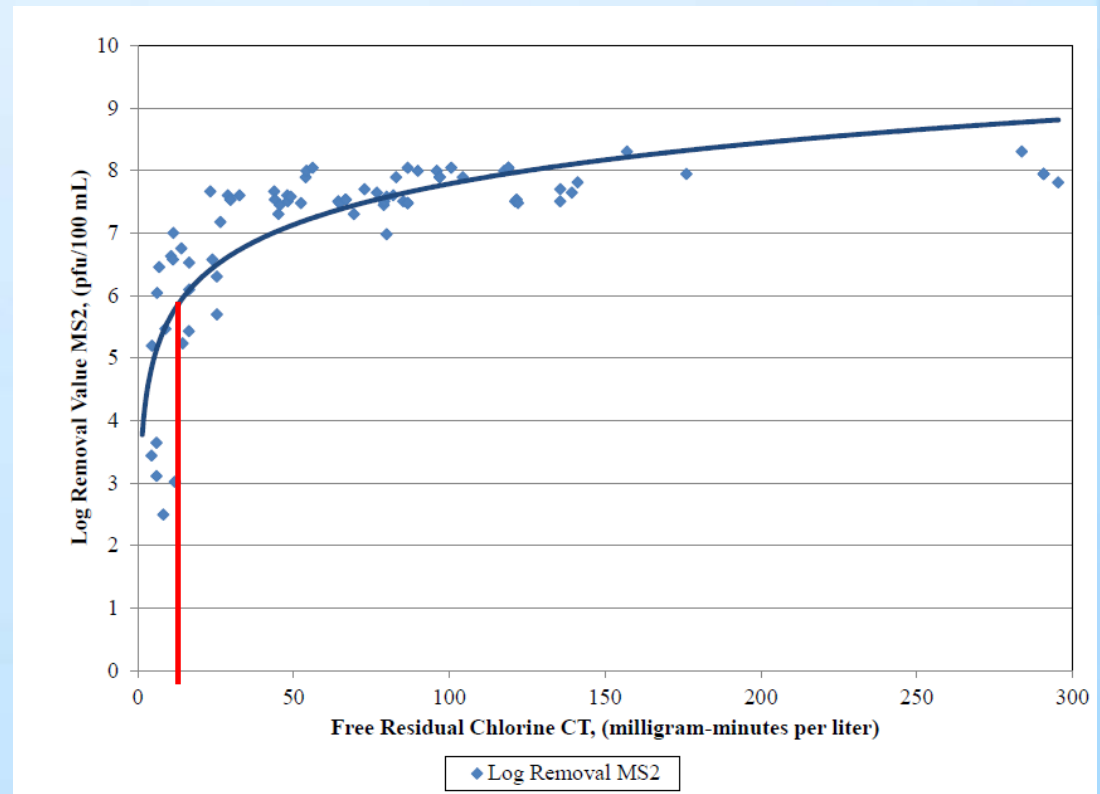
Demonstration Testing Plan – Virus Challenge

- Three samples were collected from the inlet to the chlorine contactor (before chlorine injection)
- Two other taps along the contactor



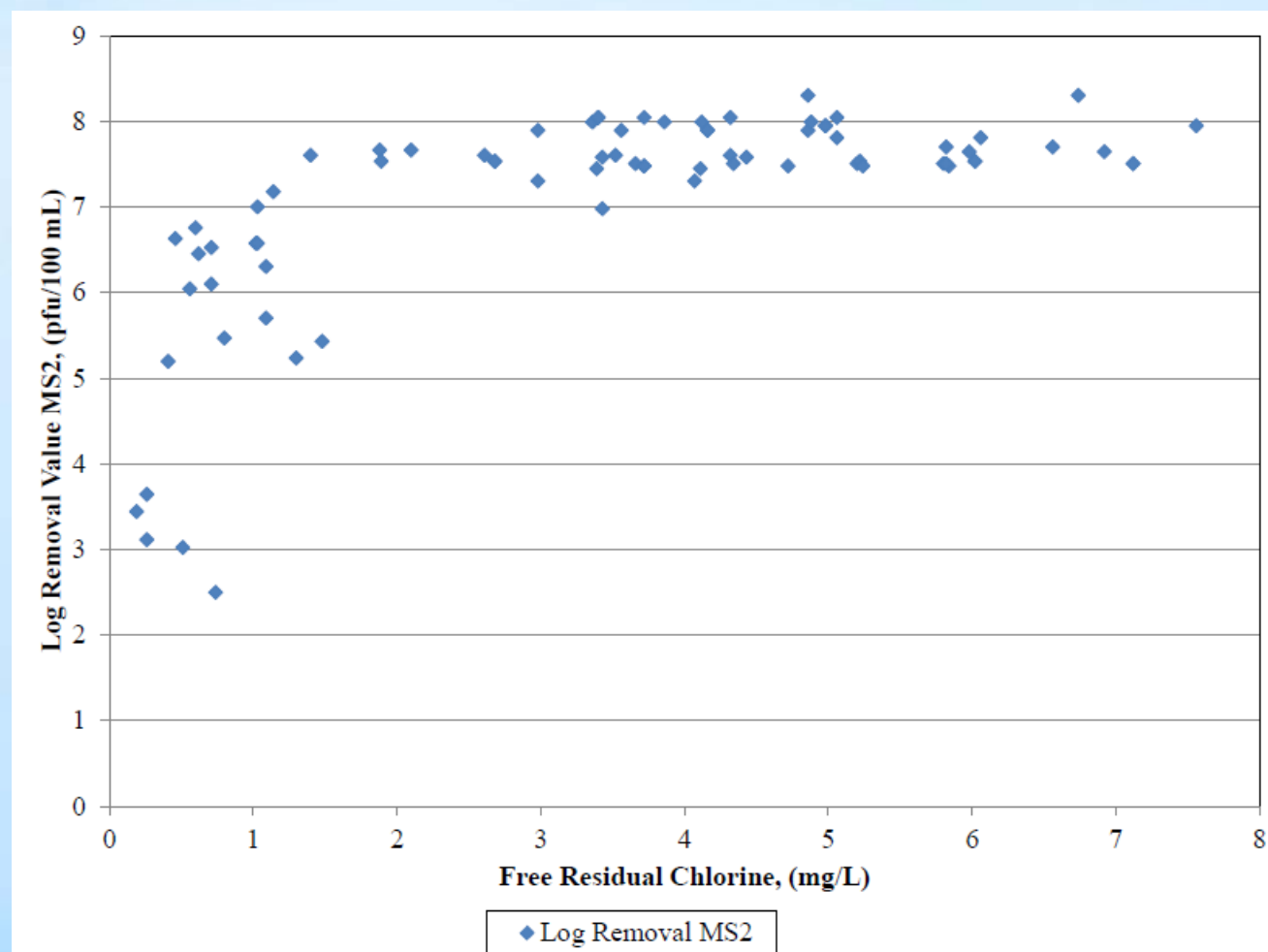
Demonstration Testing Plan – Virus Challenge

- Chlorine residual,
- Modal contact time, and
- CT value to ensure 5-log virus inactivation and compliance with the Title 22 total coliform limits



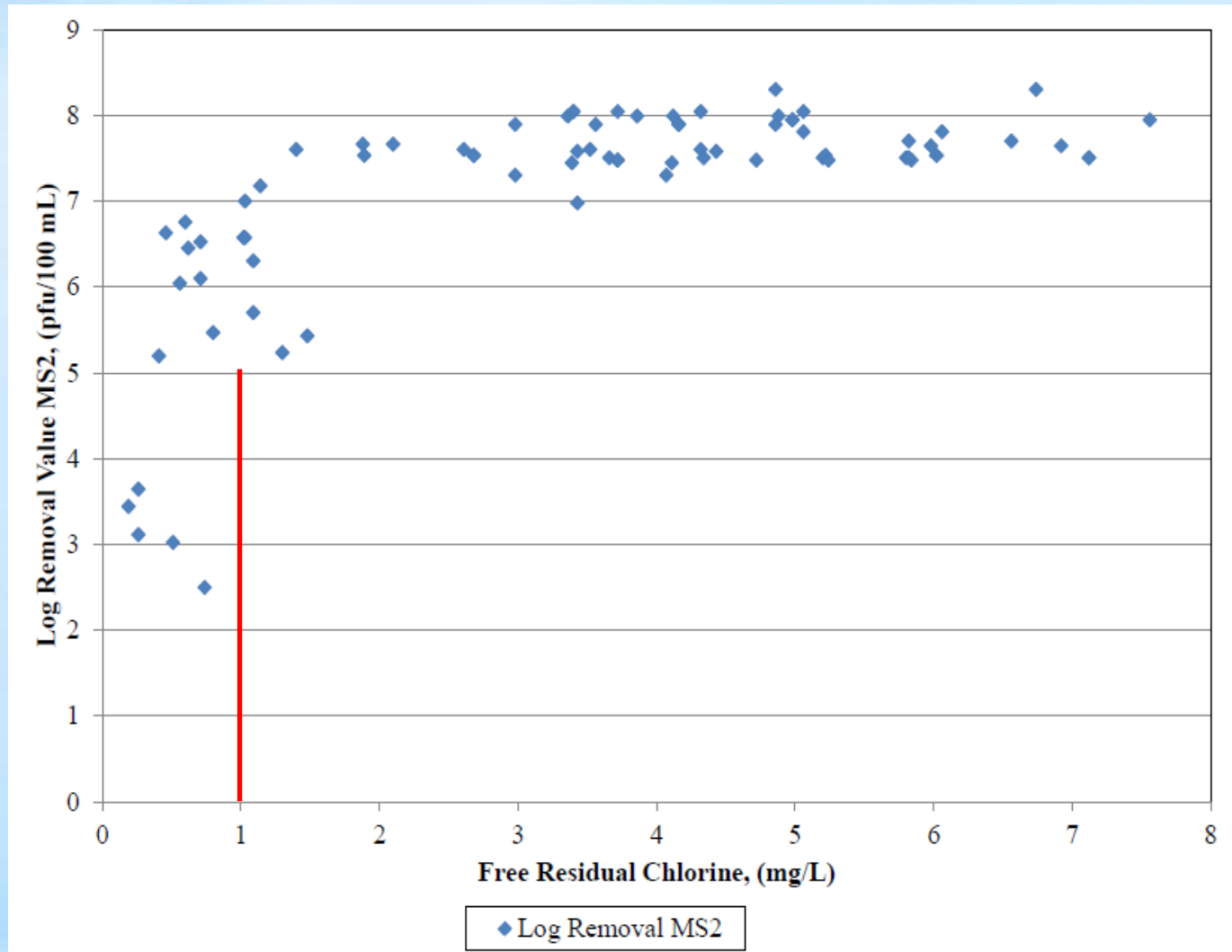
Variable Chlorine Demand & Breakpoint Chlorination

- Ammonia reached chlorine contactor
- At times the FRC dropped below 1 mg/L because breakpoint chlorination exceeded dosing.



Variable Chlorine Demand & Breakpoint Chlorination

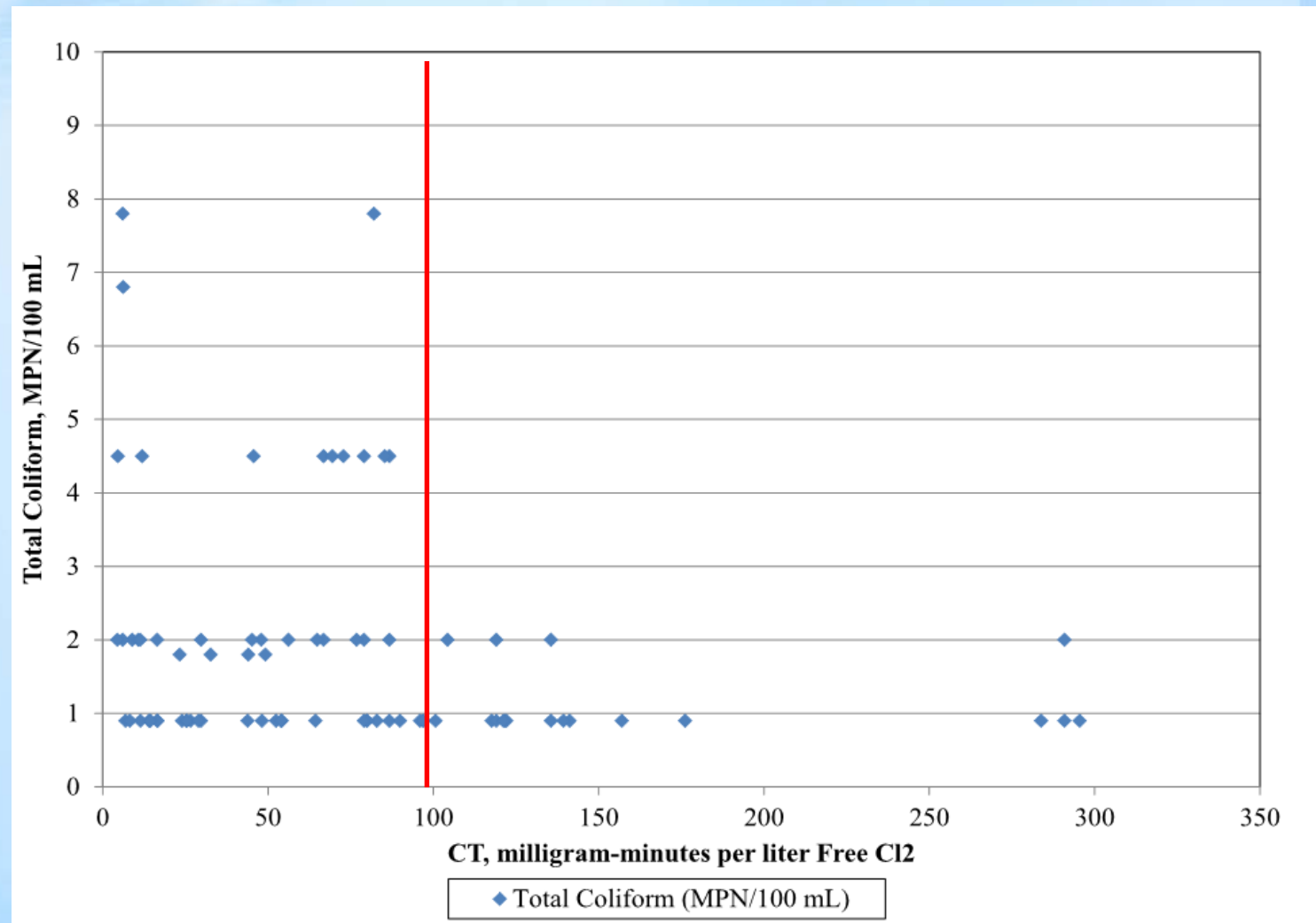
- A FRC greater than 1 mg/L created 5 log removal of MS2
- CATT letter requires a minimum FRC of 1.3 mg/L for virus



Total Residual Chlorine CT and Total Coliform

Total coliform
disinfection to meet
2.2 total coliform
(MPN/100 mL)

At FRC CT above
100 mg•min/L.



Chlorine Dosing Control

- Two control strategies,
 - Ammonia analyzer and
 - Two chlorine analyzers (upstream and downstream)
- First Strategy
 - One chlorine analyzer near the entrance (3 to 5 minutes)
 - One chlorine analyzer near the effluent (120 minutes)
 - Effluent chlorine residual process value compared to the set point
 - If the process value was less than the set point,
 - then the set point at the influent location was increased
 - using a proportional-integral derivative (PID) control loop.
 - Compound cascade loop
 - Full scale plant will also respond to changes inflow.

Chlorine Dosing Control

- Second Strategy
 - If NH_3 concentration measured above 0.5 mg/L
 - Then initial metering pump set point is adjusted by a multiplier
 - 10:1 ratio of chlorine to NH_3
 - add additional 8^* mg/L of chlorine
 - Continuously adjust based on a compound cascade loop



DDW Conditional Acceptance

- Turbidity:
 - An average of 1.5 NTU within a 24-hour period;
 - 2.5 NTU more than 5 percent of the time within a 24-hour period;
 - 5 NTU at any time.
- Maintain FRC CT 162.5 mg•min/L
- Maintain a minimum free chlorine modal contact time of 30 minutes
- Maintain a minimum FRC concentration of 1.3 mg Cl₂/L

Plan for Full Scale Implementation

- Filtration Unit Process Capacity
 - Based on a firm 217 mgd, at 7.5 gpm/sf, with at least one filter cell out of service for maintenance, and up to three filter units in backwash.
- Disinfection Unit Process Capacity
 - FRC CT above 162.5 mg•min/L,
 - Minimum FRC 1.3 mg/L (when flows are low)
 - Modal contact time 46 minutes
 - FRC 3.6 mg/L (at peak wet weather flow)
 - Baffling factor of 0.8 – confirmed by CFD and tested by tracer study
- Control Strategies and Analyzers
 - Ammonia analyzers to monitor filter effluent
 - Upstream chlorine analyzer (3 minutes into DCB flow path)
 - Downstream chlorine analyzer

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Saving of Over \$100 Million

- GMF Costs could be reduced by going from 5 gpm/sf to 7.5 gpm/sf
 - Saving of greater than \$53 million
- DCB costs were reduced by going from 90 minute modal contact time to 46 minute modal contact time
 - Saving of greater than \$47 million

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Applicability to Other Facilities

- DDW has previously accepted 7.5 gpm/ft² filtration rates for tertiary recycled water
 - Monterrey Regional Water Pollution Control Agency,
 - Delta Diablo Sanitation District, (received waiver)
 - City of Santa Rosa Laguna Treatment Plant (received waiver)
 - Regional San (received CATT)
 - Others.....

Applicability to Other Facilities

- Reasons for lower CT with Free Chlorine:
 - Does your upstream biological process remove ammonia and nitrite reliably?
 - Free chlorine achieves better disinfection than chloramines at much lower CT values
 - Others have demonstrated free chlorine will work
 - Sanitation Districts of Los Angeles County (SDLAC), San Jose Creek East Water Reclamation Plant (SJCEWRP).,
 - Regional San,
 - Others

Questions?

