



Two-stage, Fixed-bed Biodenitrification at the City of Delano: Pilot Testing to Full-scale Implementation

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Giridhar Upadhayaya, Jeff Riley, Pei-Shin Wu

This presentation will cover...

Background



Delano Piloting Results

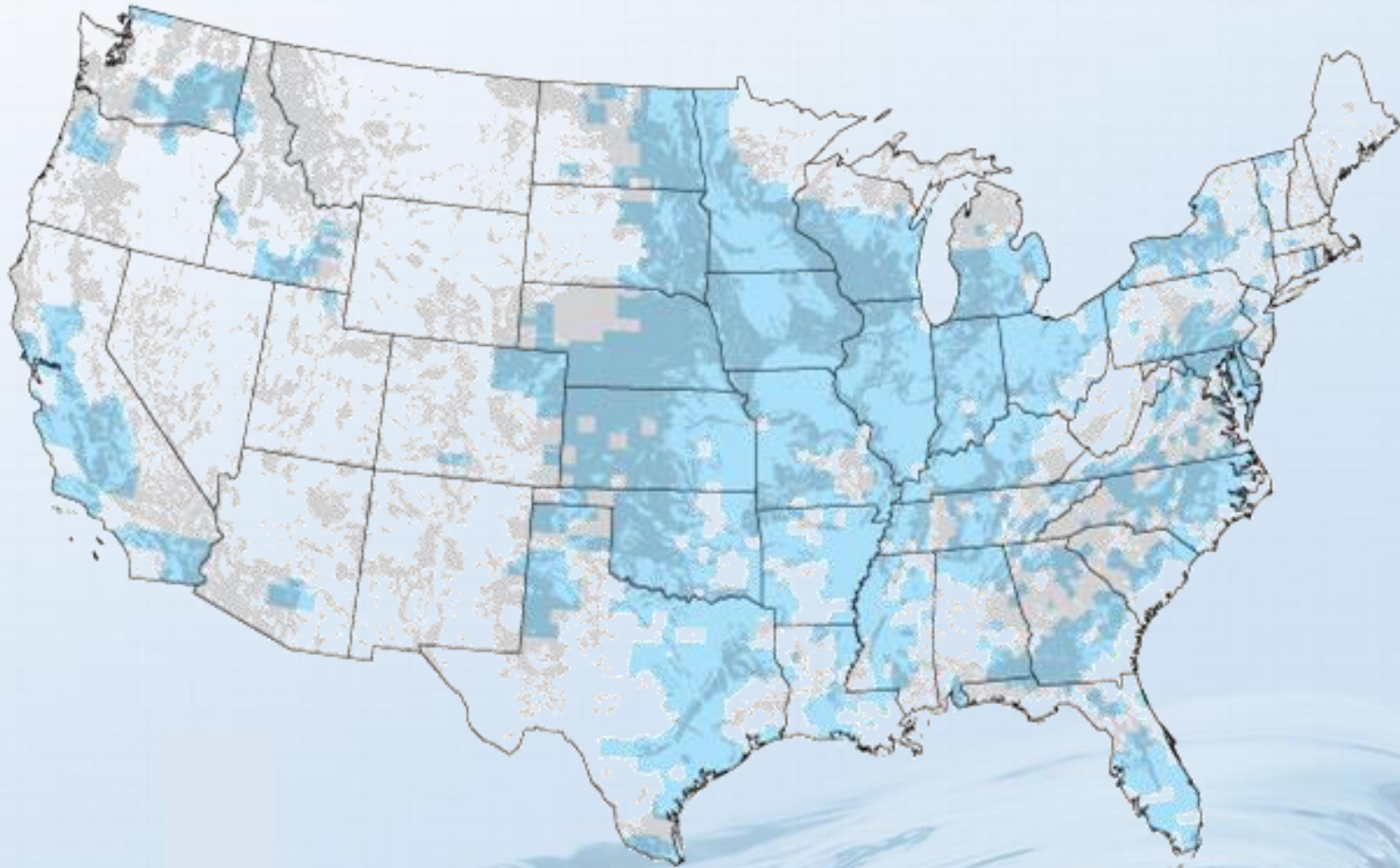


**Full-Scale Construction
and Operation**

Background

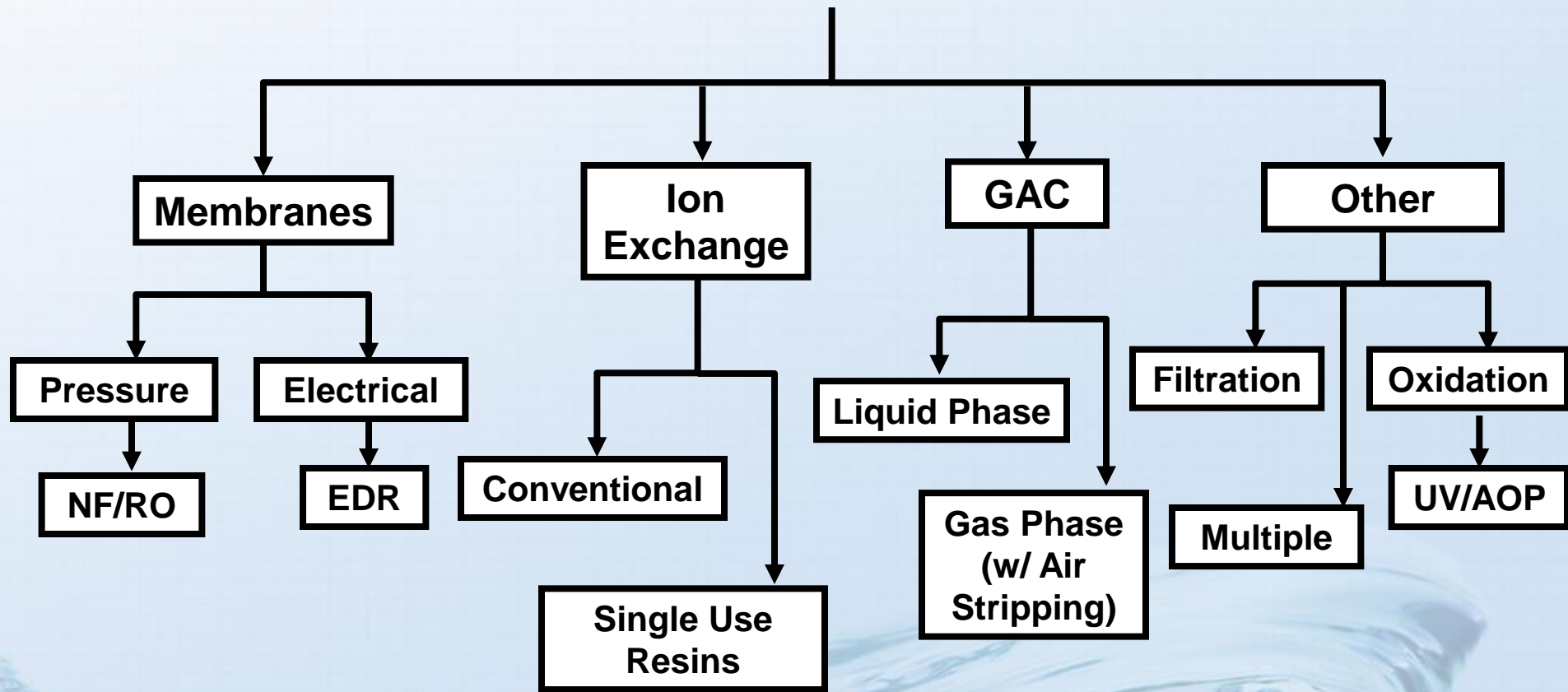


Nitrate Is One of the Most Common Groundwater Contaminants in the US



Universe of Treatment Alternatives

Nitrate, VOCs, Cr(VI)



Existing Technologies Present Some Challenges

- Generate high-strength, contaminant-laden waste
- Often target a single contaminant
stacked treatment processes required for multi-contaminant applications → increased costs & footprint
- O&M costs can be substantial
high headloss across multiple unit processes; waste handling/disposal; high media regeneration or change-out frequency, etc.
- Treatment efficiency often impacted by raw water quality



Two-Stage, Fixed-Bed Biotreatment Realizes Multiple Benefits



Multiple
contaminants



Contaminant
destruction



High water
recovery



Low energy/
ops costs

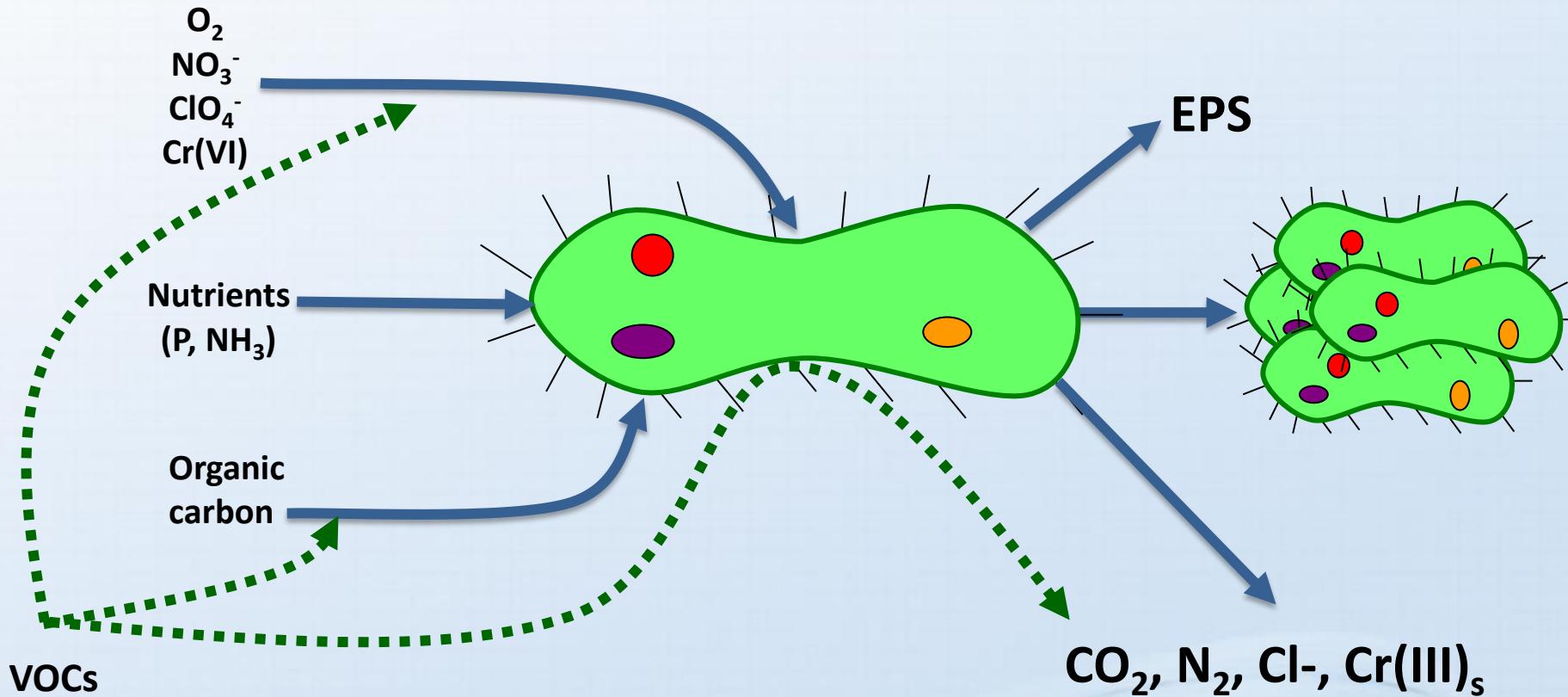


Natural & Sustainable
Process

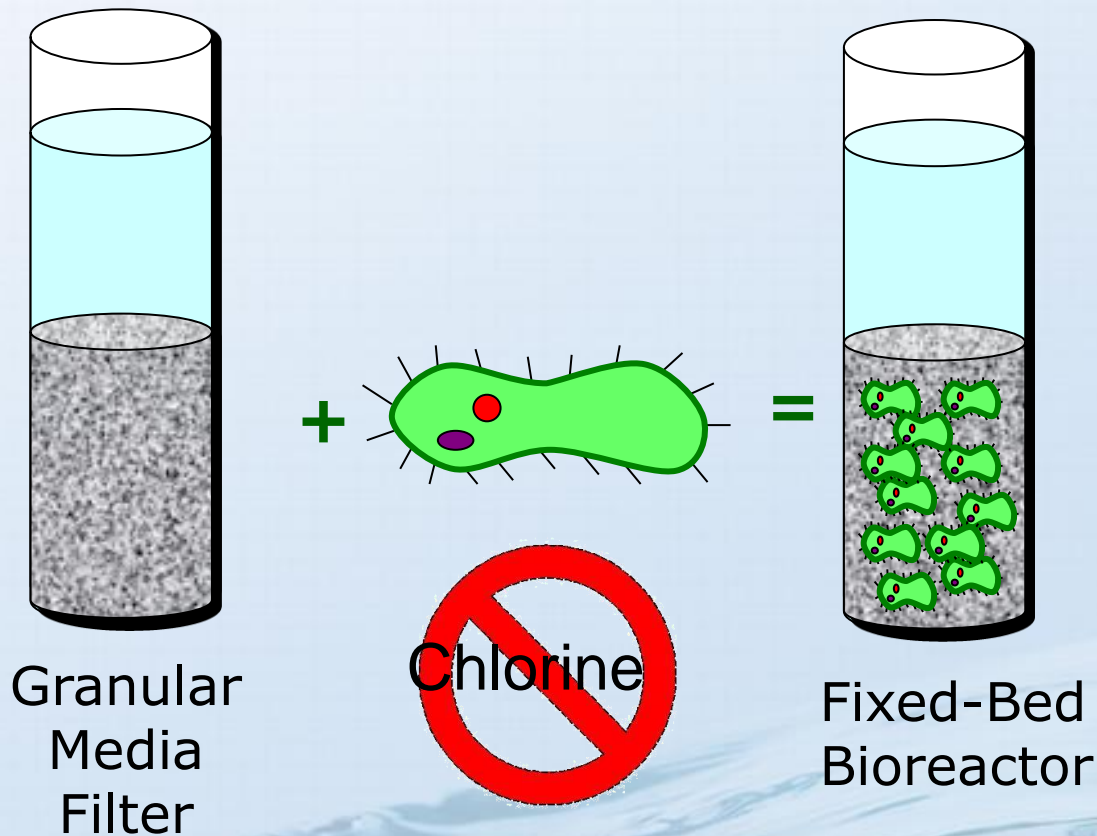


Robust

Bacteria Oxidize and Reduce Contaminants to Generate Energy and Grow

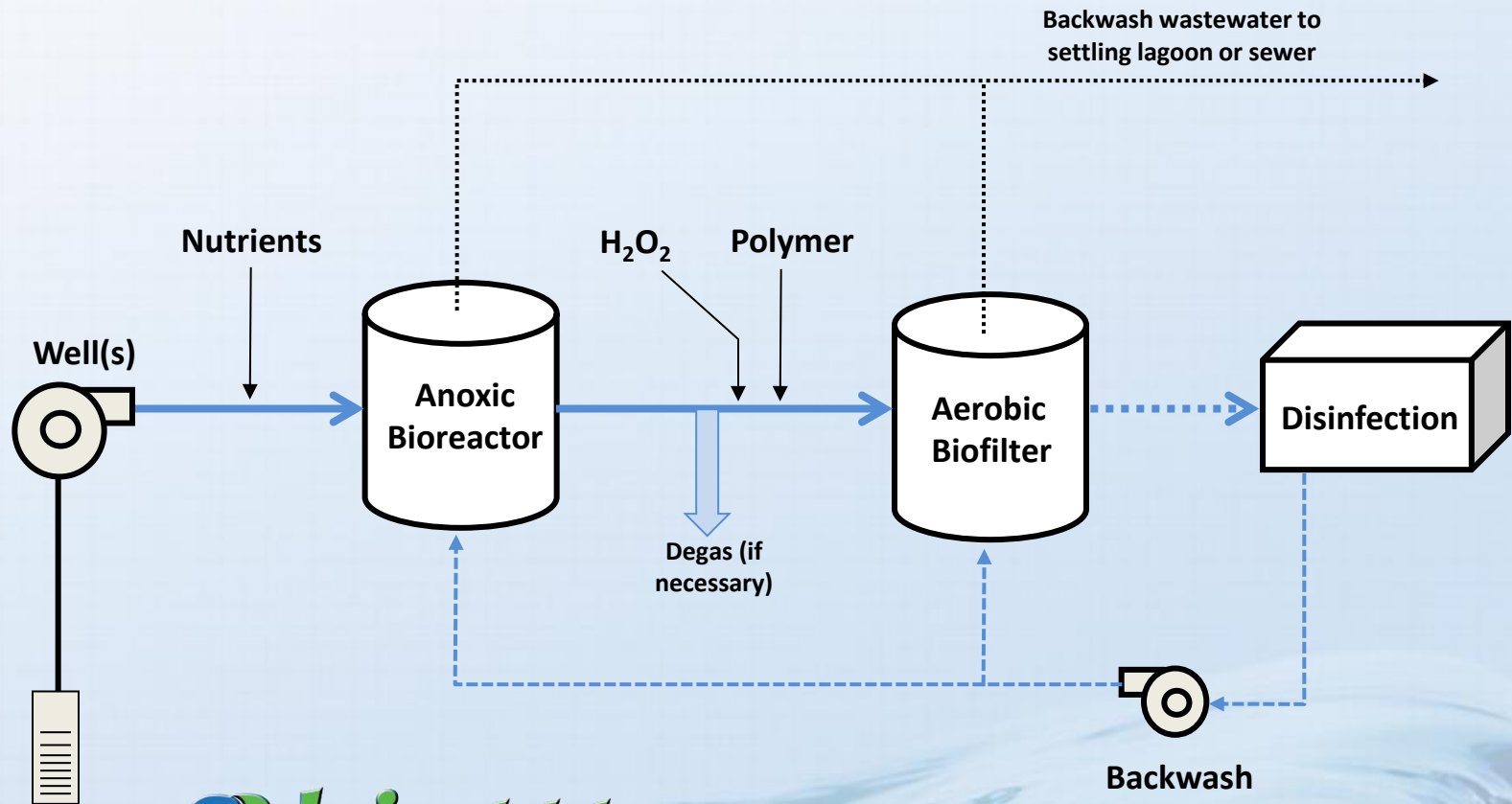


Fixed-Bed Biological Treatment is Based On Conventional Granular Media Filtration



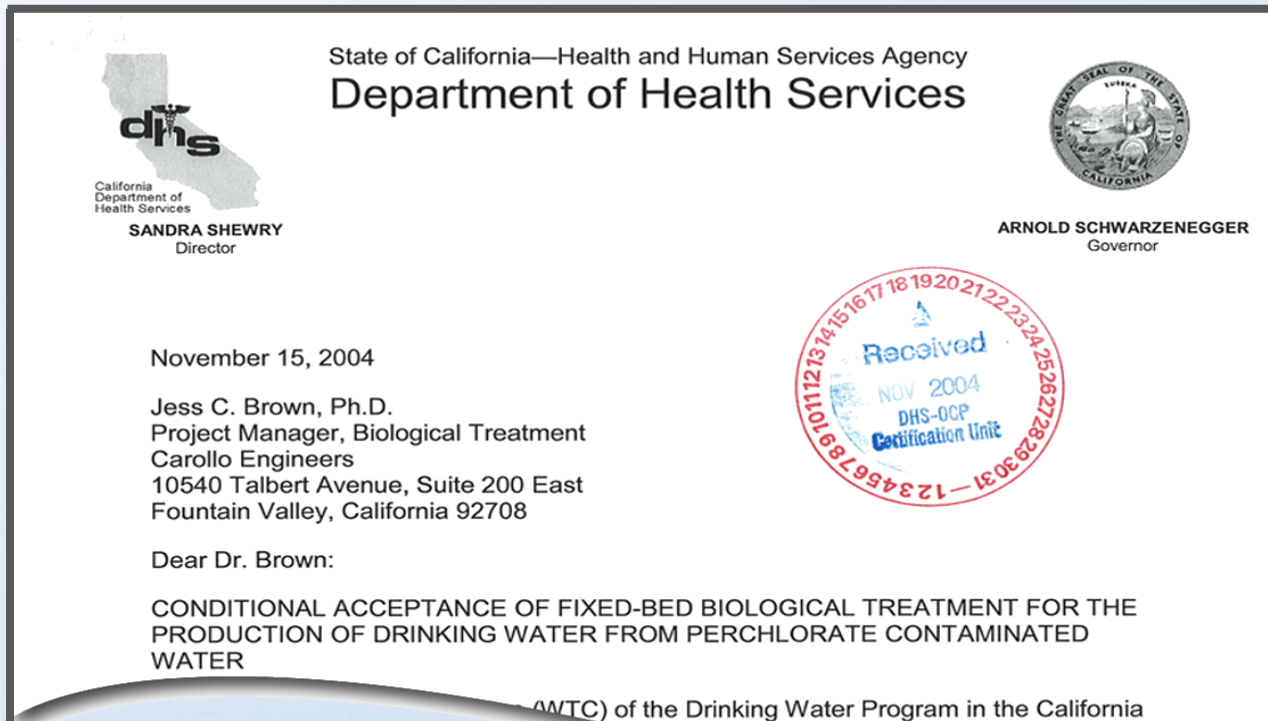
Biologically-Tailored, Two-Stage Treatment Approach :

Meets water quality objectives and is designed for automated operation and robust performance




biotta™

Fixed-Bed Biological Treatment Received DDW Conditional Approval in 2004



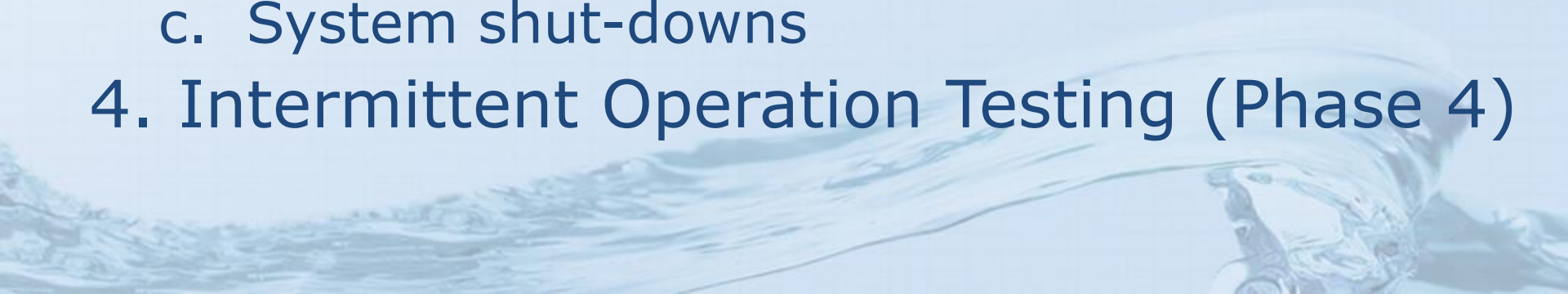
Delano Well 35 Project Objectives

1. Demonstrate treatment effectiveness for removing nitrate from Well 35 groundwater
 2. Demonstrate system robustness
 3. Assess full-scale operation requirements
 4. Support water supply permit application to operate full-scale facility in rural settings
 5. Familiarize City staff with the system
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- A decorative graphic at the bottom of the slide showing a splash of water with a glass rim visible on the right side.

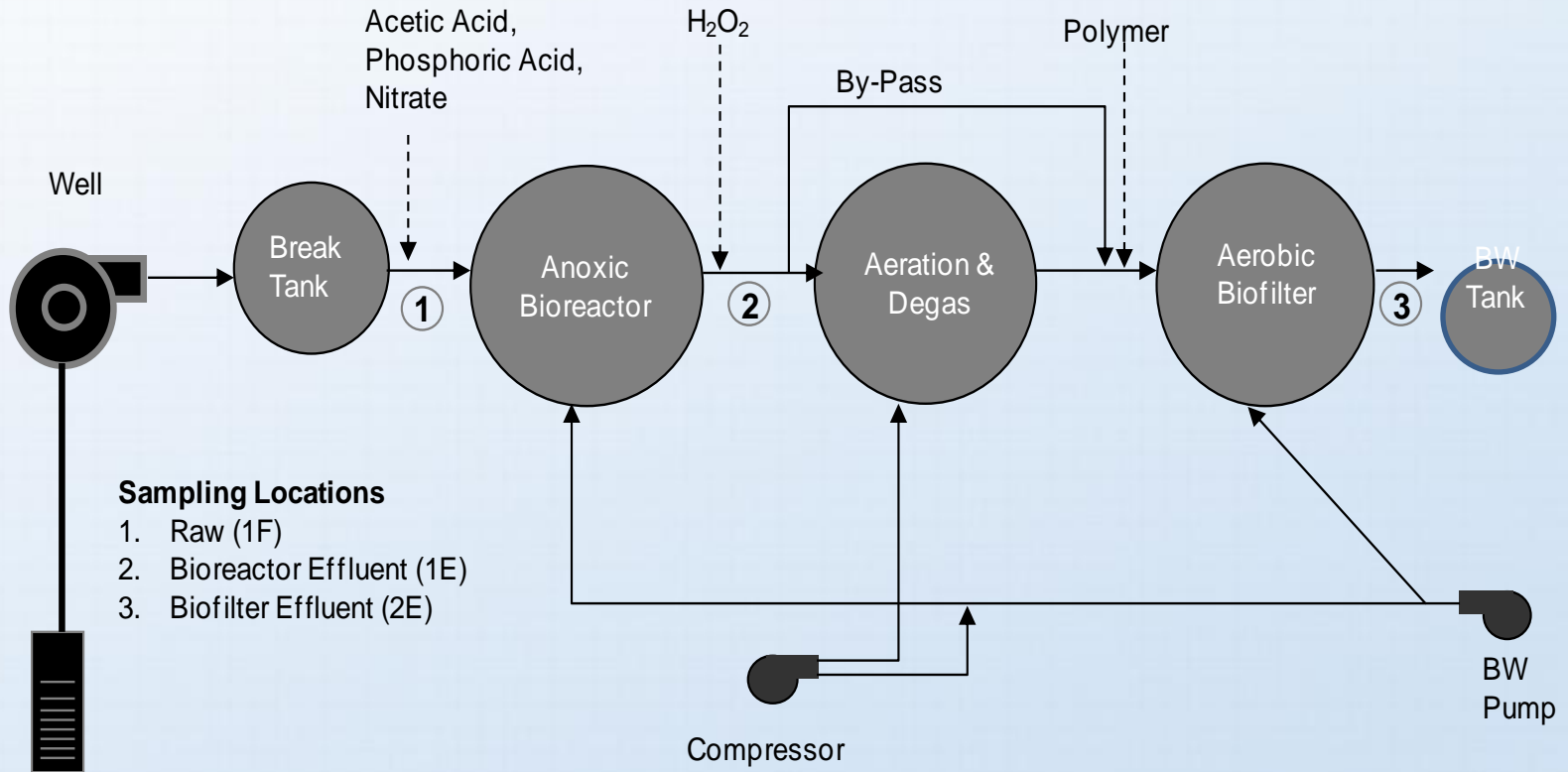
Delano Piloting Results



Well 35 Pilot Study – Testing Phases

1. Acclimation & Optimization (Phase 1)
 2. Steady-State Operations (Phase 2)
 - a. Disinfection (CT) Testing
 - b. DBP Formation Potential (DBPFP) Testing
 3. Challenge Testing (Phase 3)
 - a. Raw water quality fluctuation
 - b. Acetic acid feed failure
 - c. System shut-downs
 4. Intermittent Operation Testing (Phase 4)
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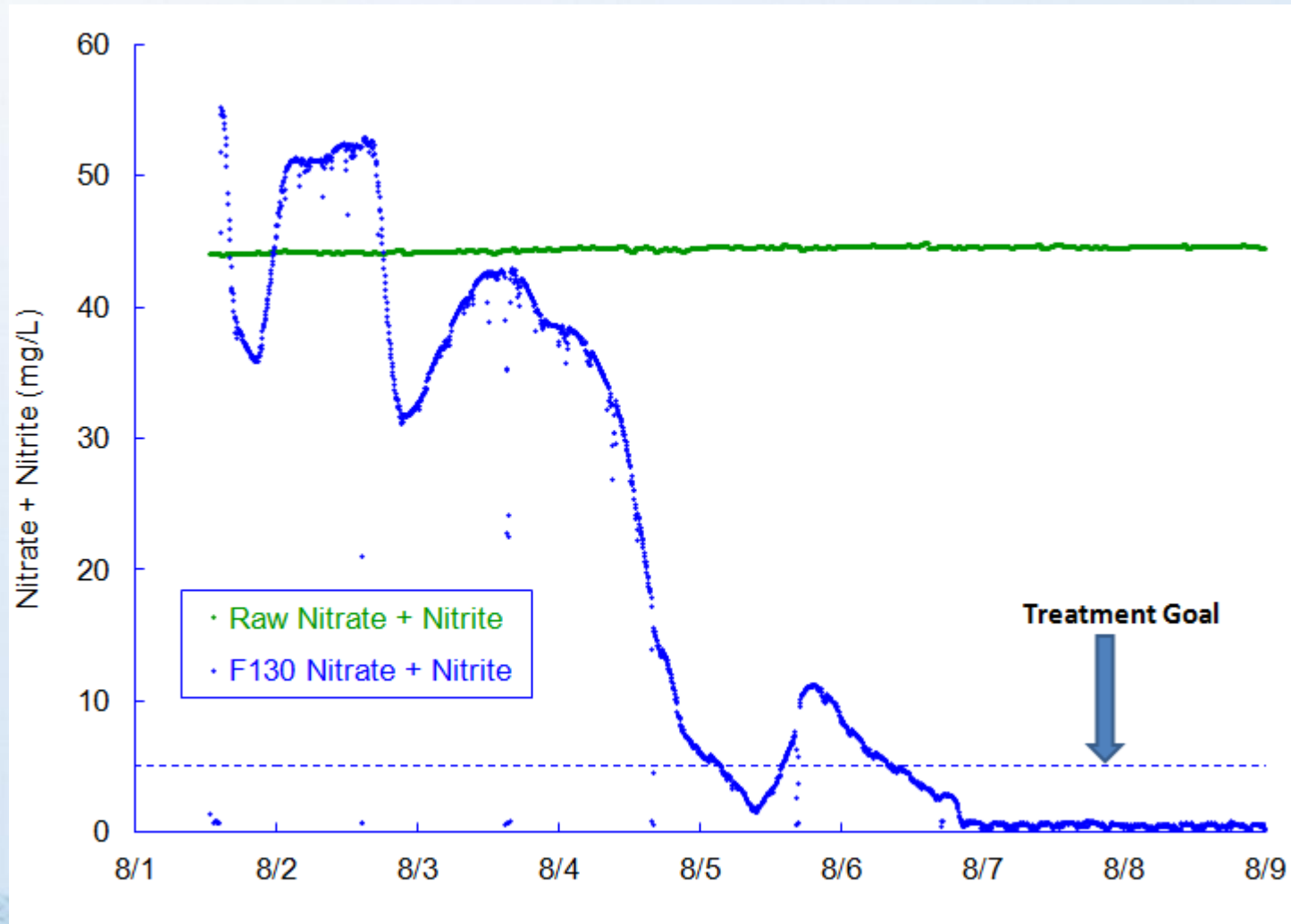
Pilot Matches Full-Scale Process Flow



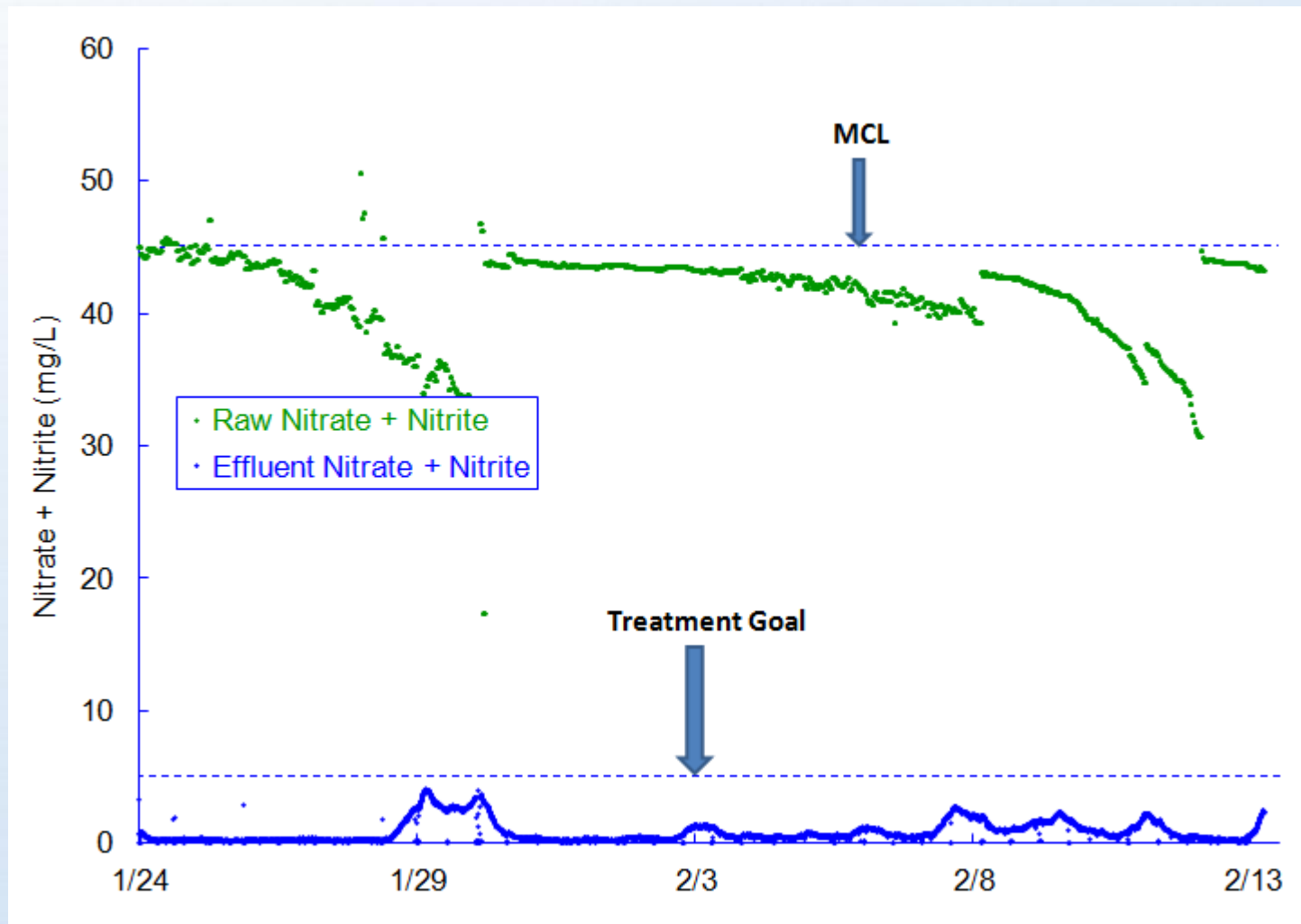
Pilot Matches Full-Scale Process Flow



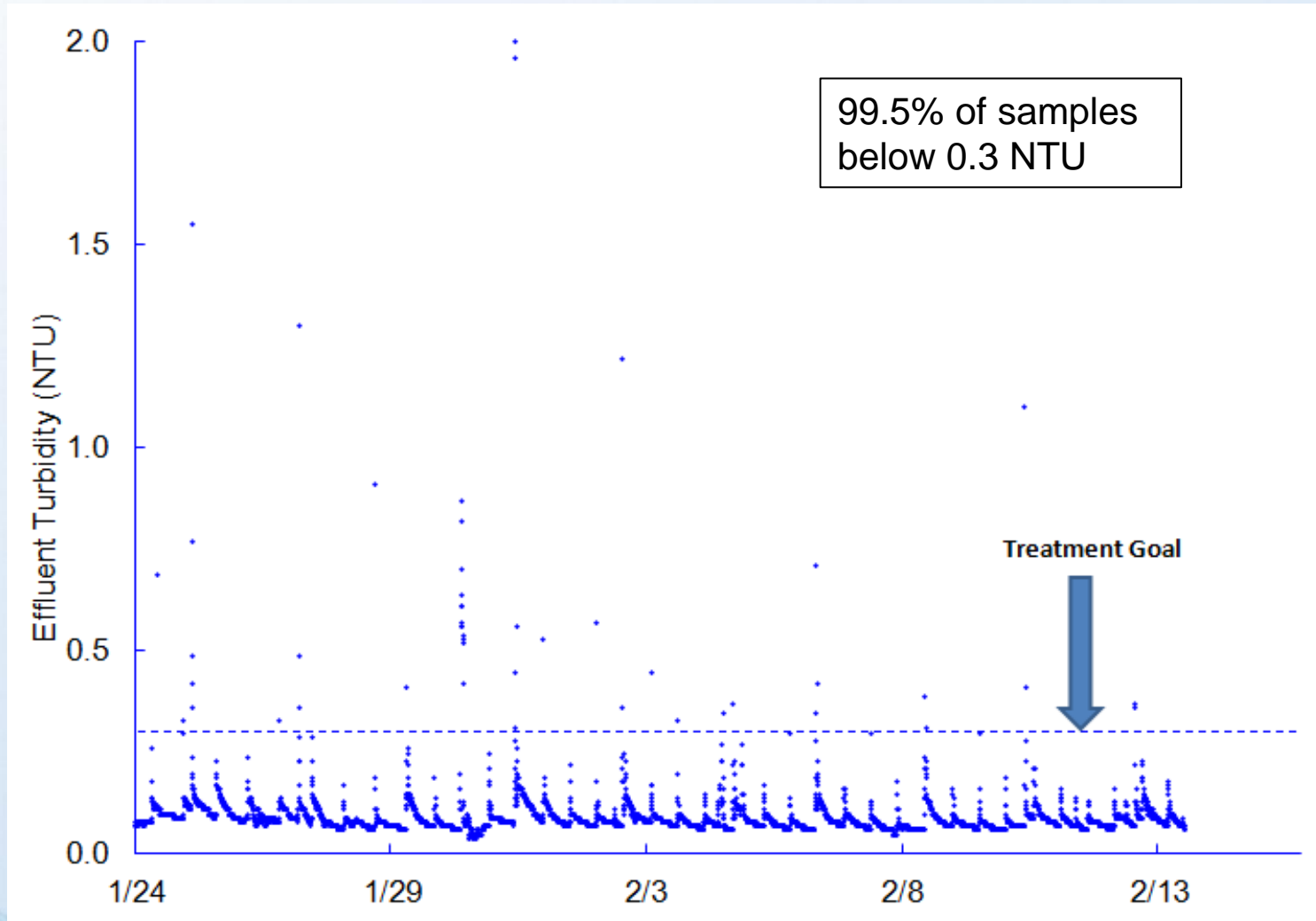
Rapid Acclimation with Fresh GAC Media



Sustained Nitrate Removal Observed



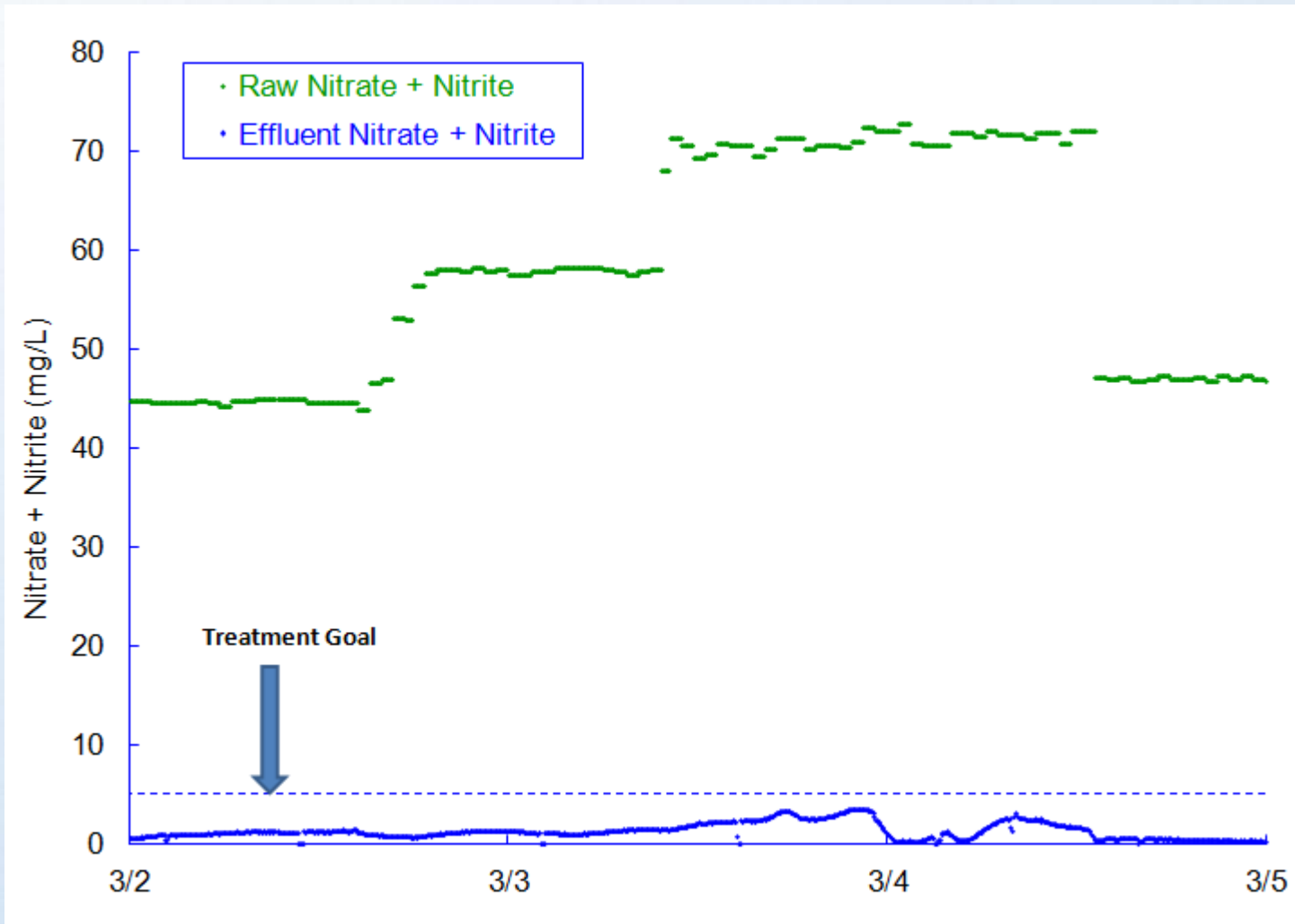
Turbidity Goals Met



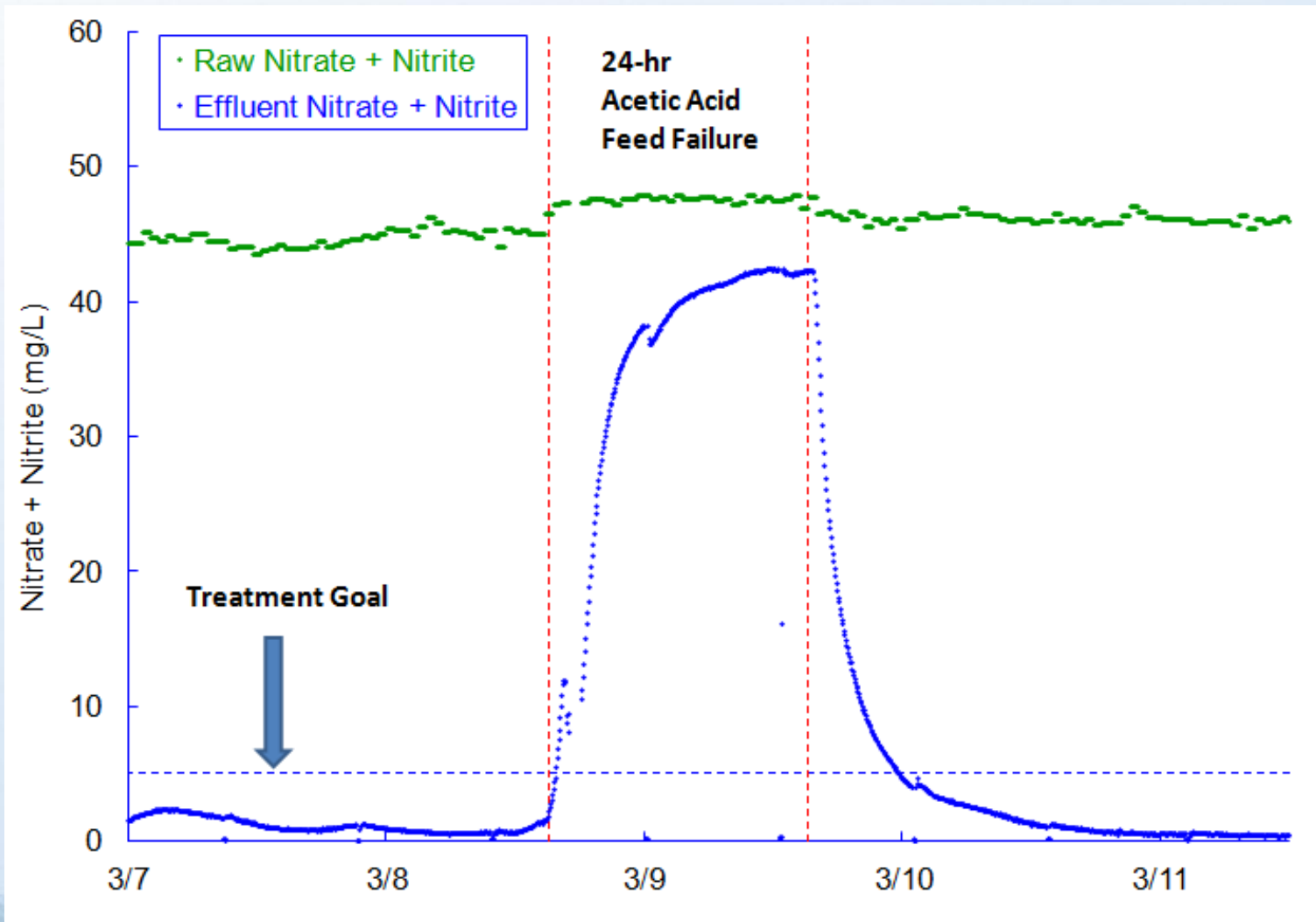
Robustness Testing



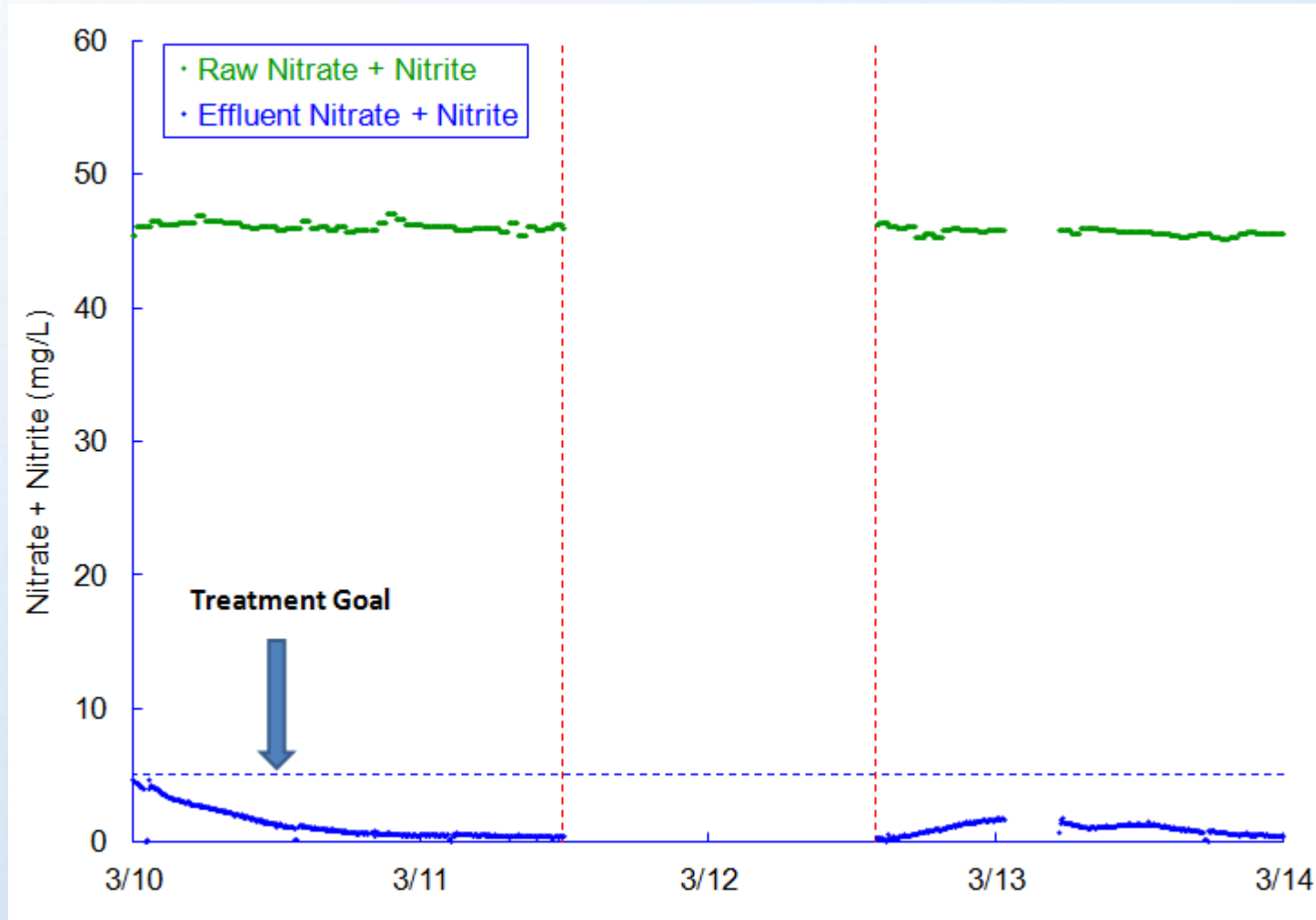
System Performance Not Impacted by Increase in Raw Water Nitrate



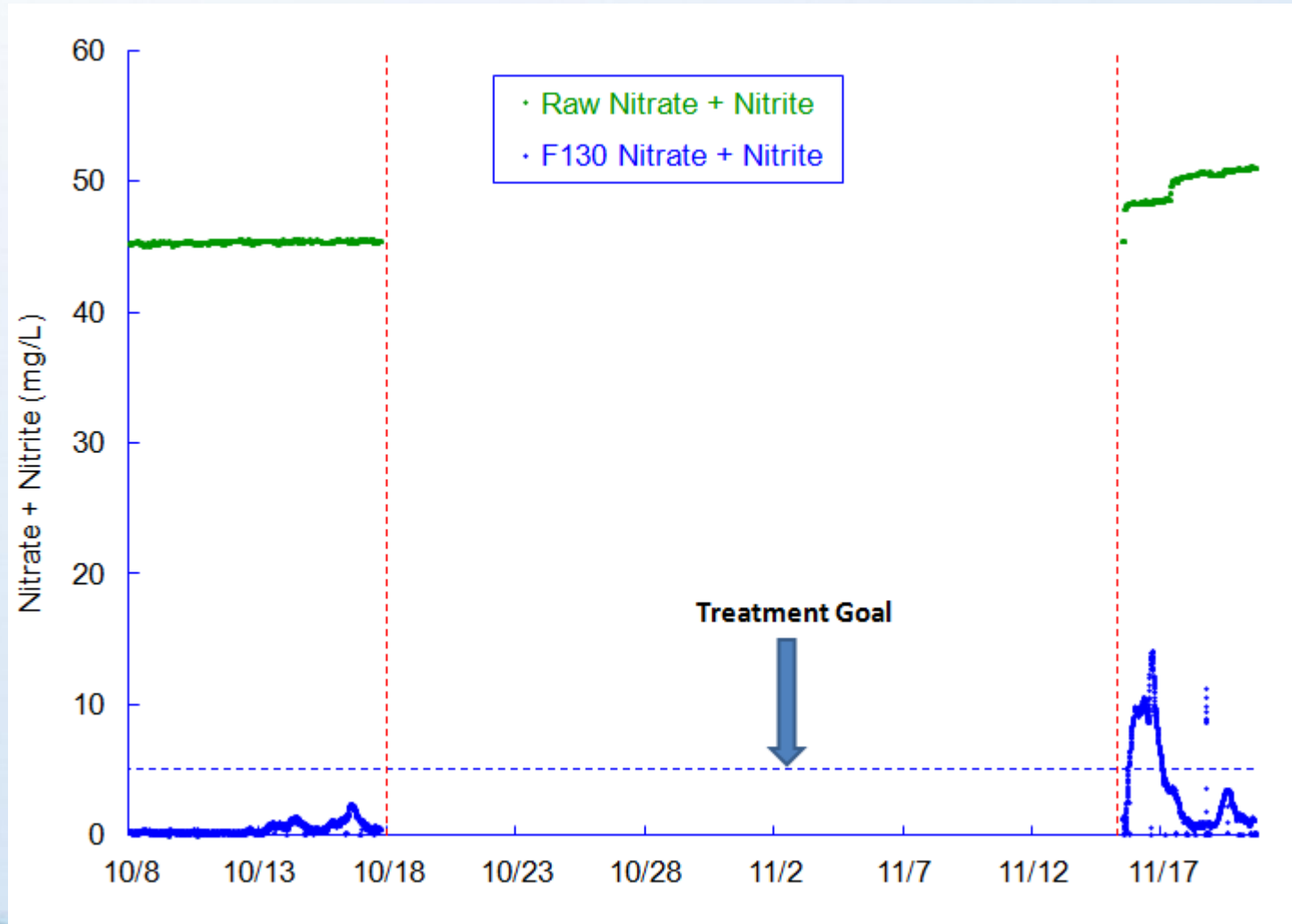
Rapid Recovery following Acetic Acid Feed Failure



System Is Robust with respect to 24-Hour System Shut-Down



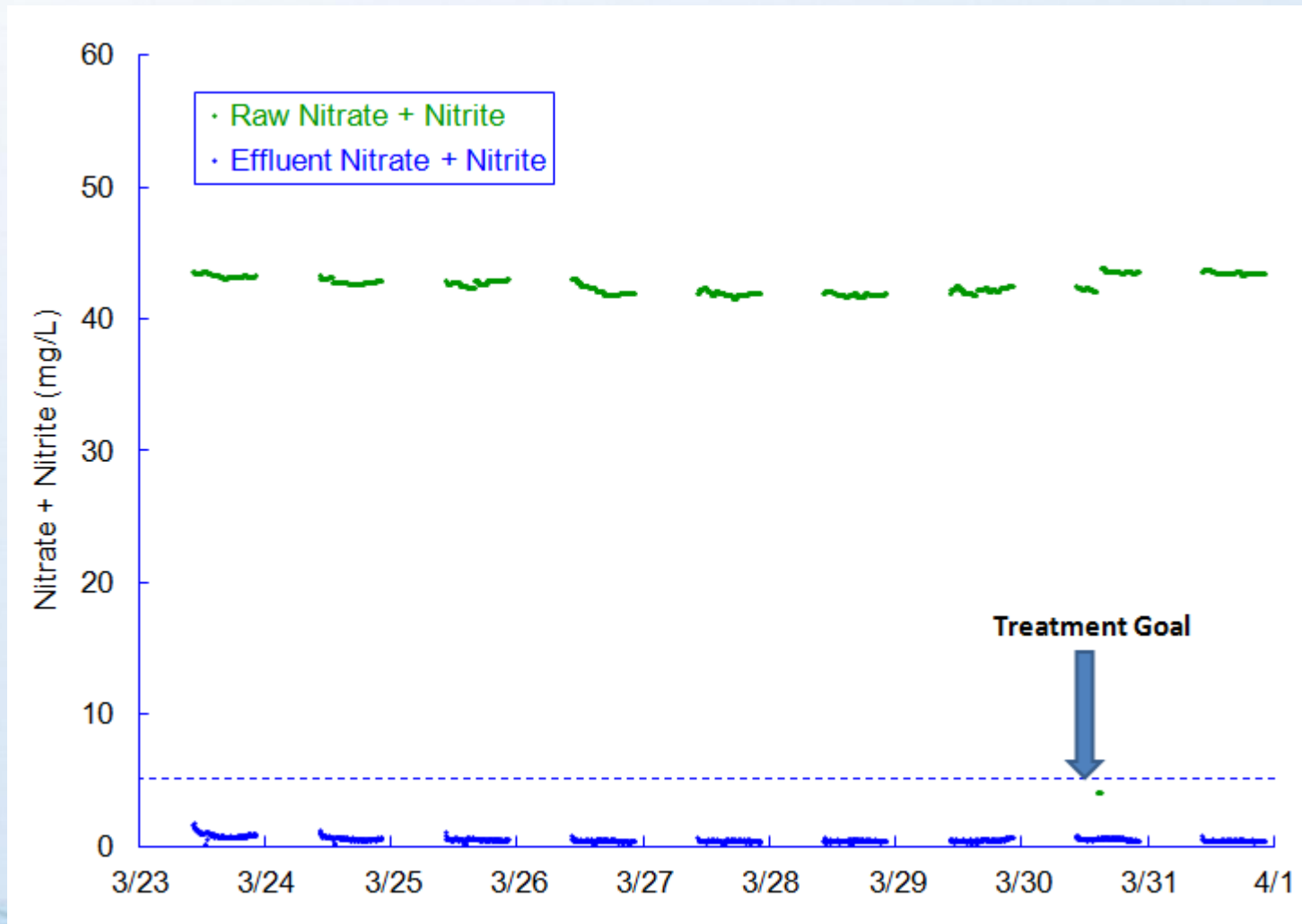
System Is Robust with respect to 1-Month System Shut-Down



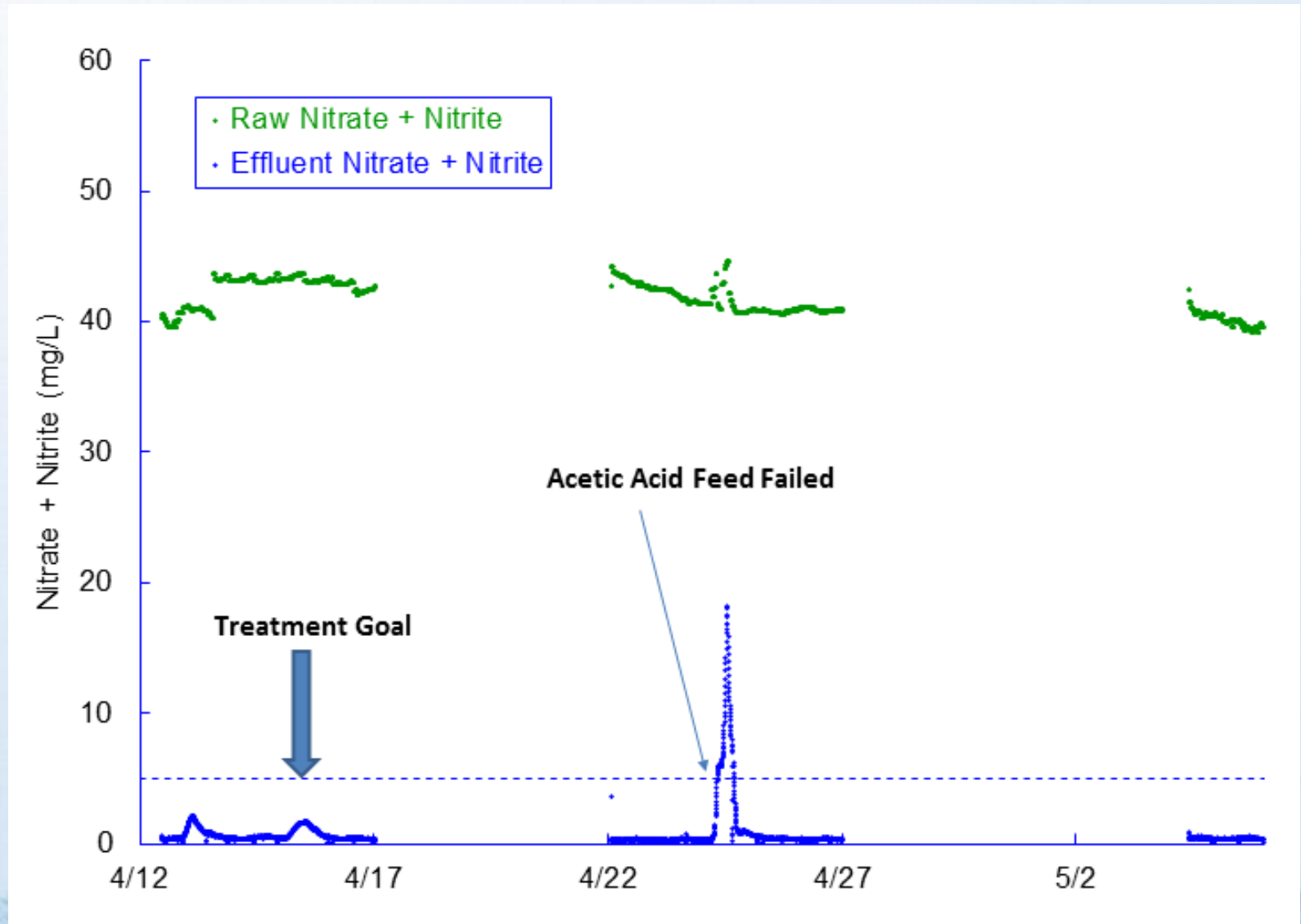
Phase 4 Testing - Intermittent Operating Scenarios

1. 24/7 Operation (Baseline Condition)
2. **On** 20 hours/**off** 4 hours
3. **On** 12 hours/**off** 12 hours
4. **On** 6 hours/**off** 18 hours
5. **On** 1 week/**off** 1 week
6. **On** 100 hours/**off** 68 hours
7. **On** 45 minutes/**off** 15 minutes, repeated for 12 hours, then **off** 12 hours
8. **On** 33 minutes/**off** 33 minutes, repeated for 12 hours, then **off** 12 hours.

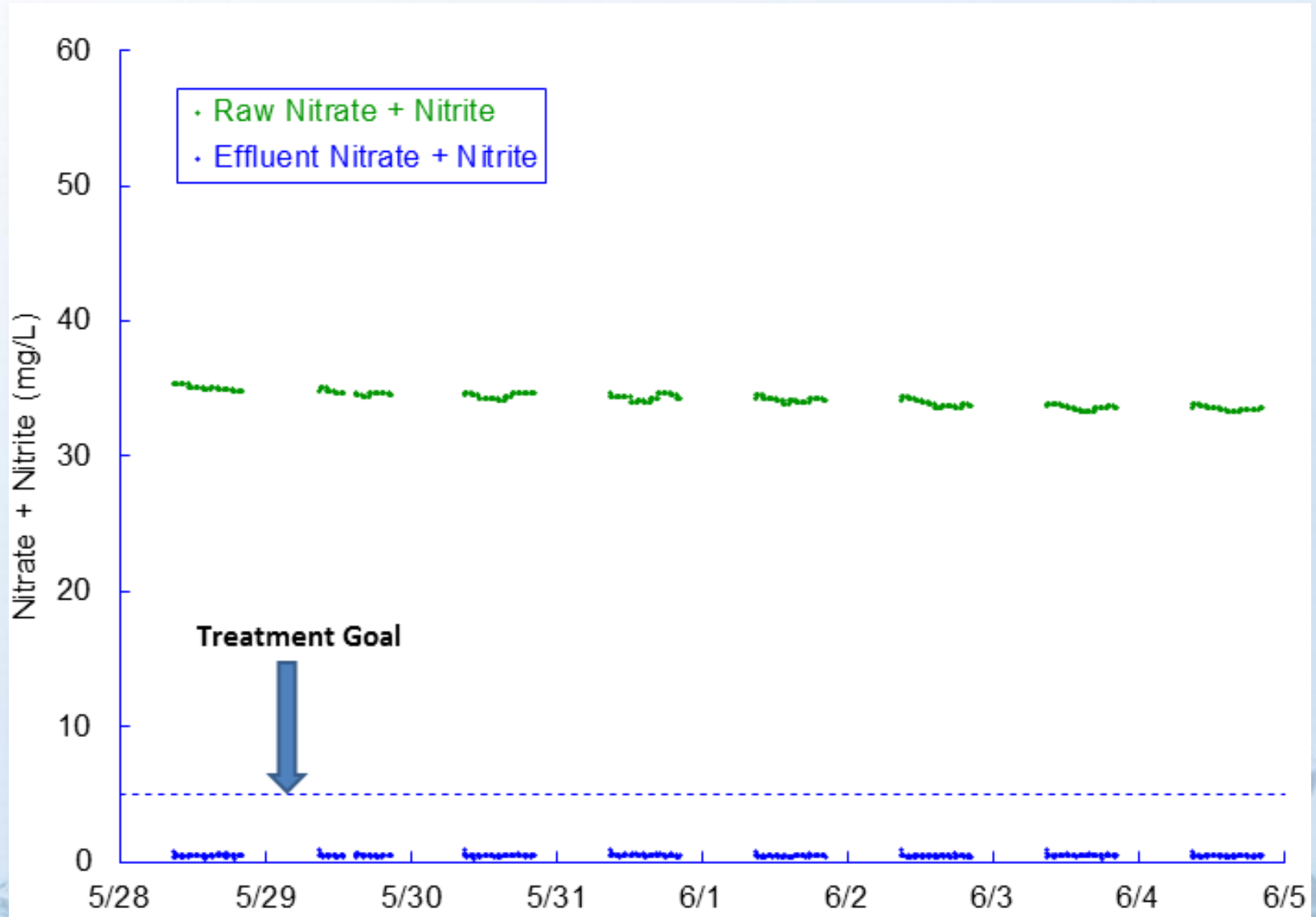
Steady Performance: 12 hrs on/12 hrs off



Steady Performance: 1 week **on**/1 week **off**



Steady Performance: 33 min **on**/33 min **off** for 12 hours, then **off** for 12 hours



Pilot Testing Summary

- Efficient nitrate removal observed and water quality objectives met
- System effluent is readily disinfected
- System effluent has a low DBP formation potential
- Backwash wastewater is low strength
- System is robust
 - Backwashing
 - Raw water nitrate fluctuation
 - Acetic acid feed failure
 - System shut-downs
 - Intermittent operation

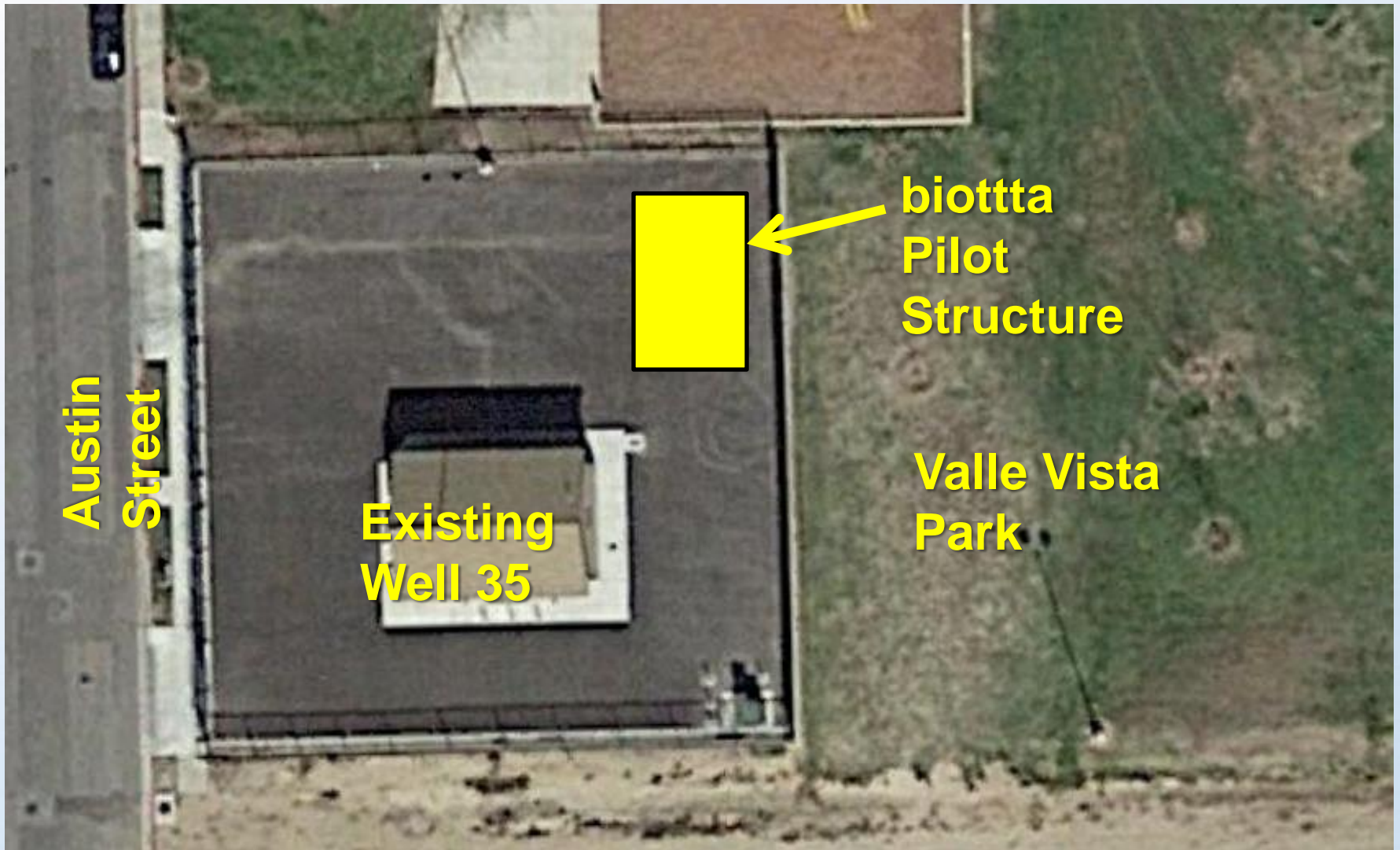
Full-Scale System



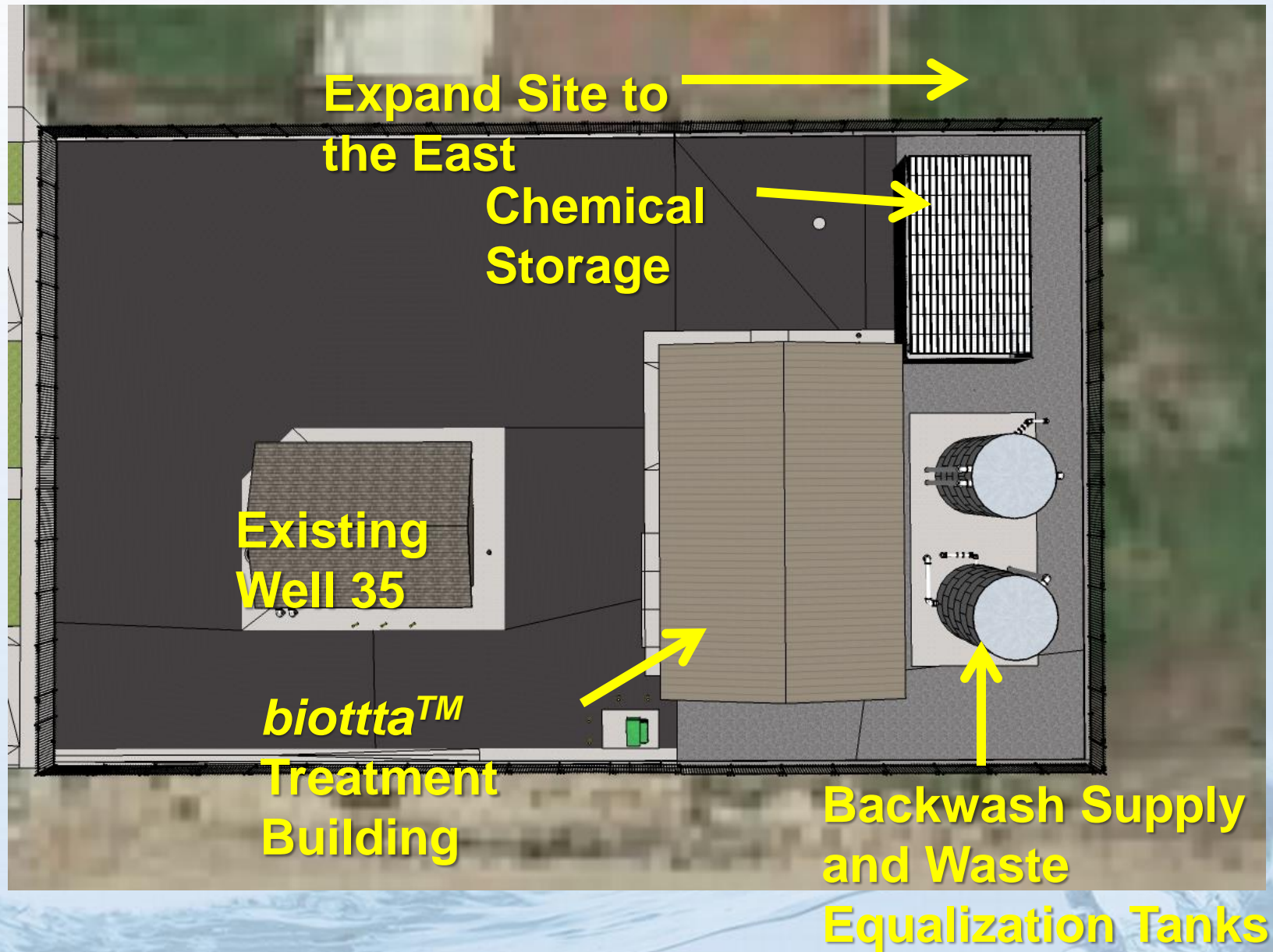
Demonstration Facility: Design Criteria

Description	Criteria
Well 35 Flow Rate	570 gpm
<i>biottta</i> TM Average Flow Rate	200 gpm
<i>biottta</i> TM Maximum Flow Rate	350 gpm
Raw Water Nitrate Concentration	45 mg/L as NO ₃
<i>biottta</i> TM Target Nitrate Concentration	5 mg/L as NO ₃
Blended Water Target Nitrate Concentration	31 mg/L as NO ₃
Number of Vessels	2
Vessel Diameter	8 feet
Bioreactor Media Type and Depth	48 inches GAC
Empty Bed Contact Time (EBCT) at Average Flow	7.6 minutes
Biofilter Media Type and Depth	36 inches GAC over 12 inches sand

Well 35: Existing Site



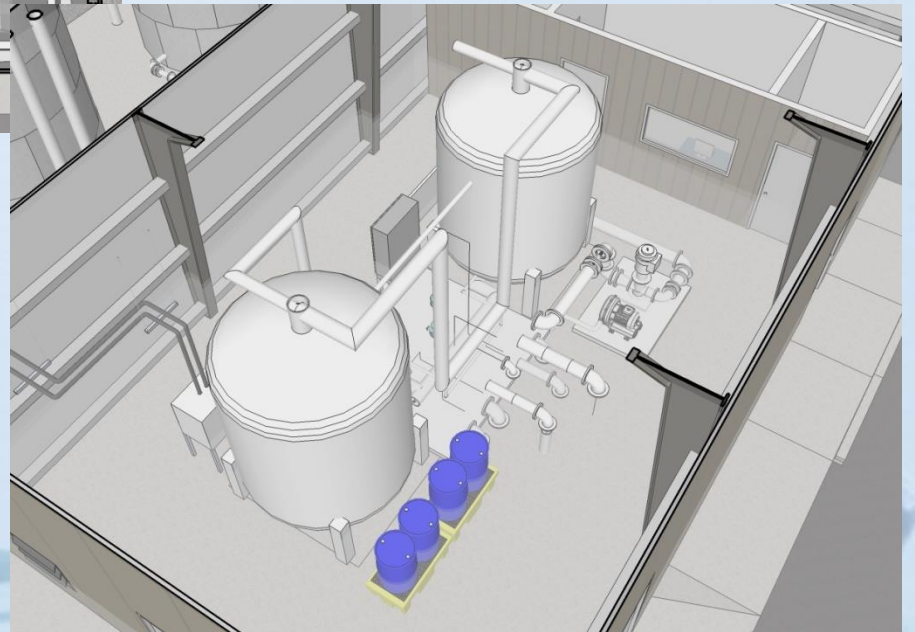
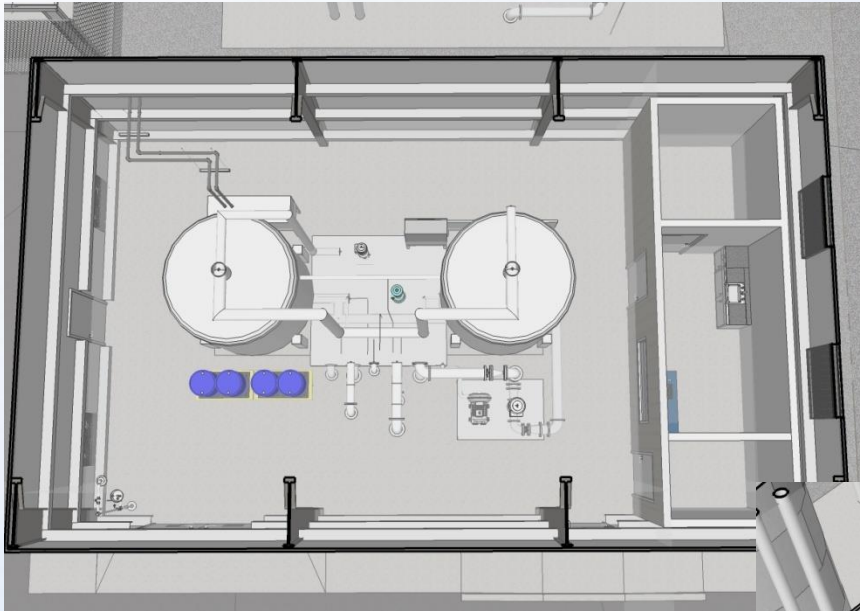
Demonstration Facility Layout



Demonstration Facility Layout



Demonstration Facility Layout



Full-scale System Construction



Full-scale System Construction



Full-scale System Construction



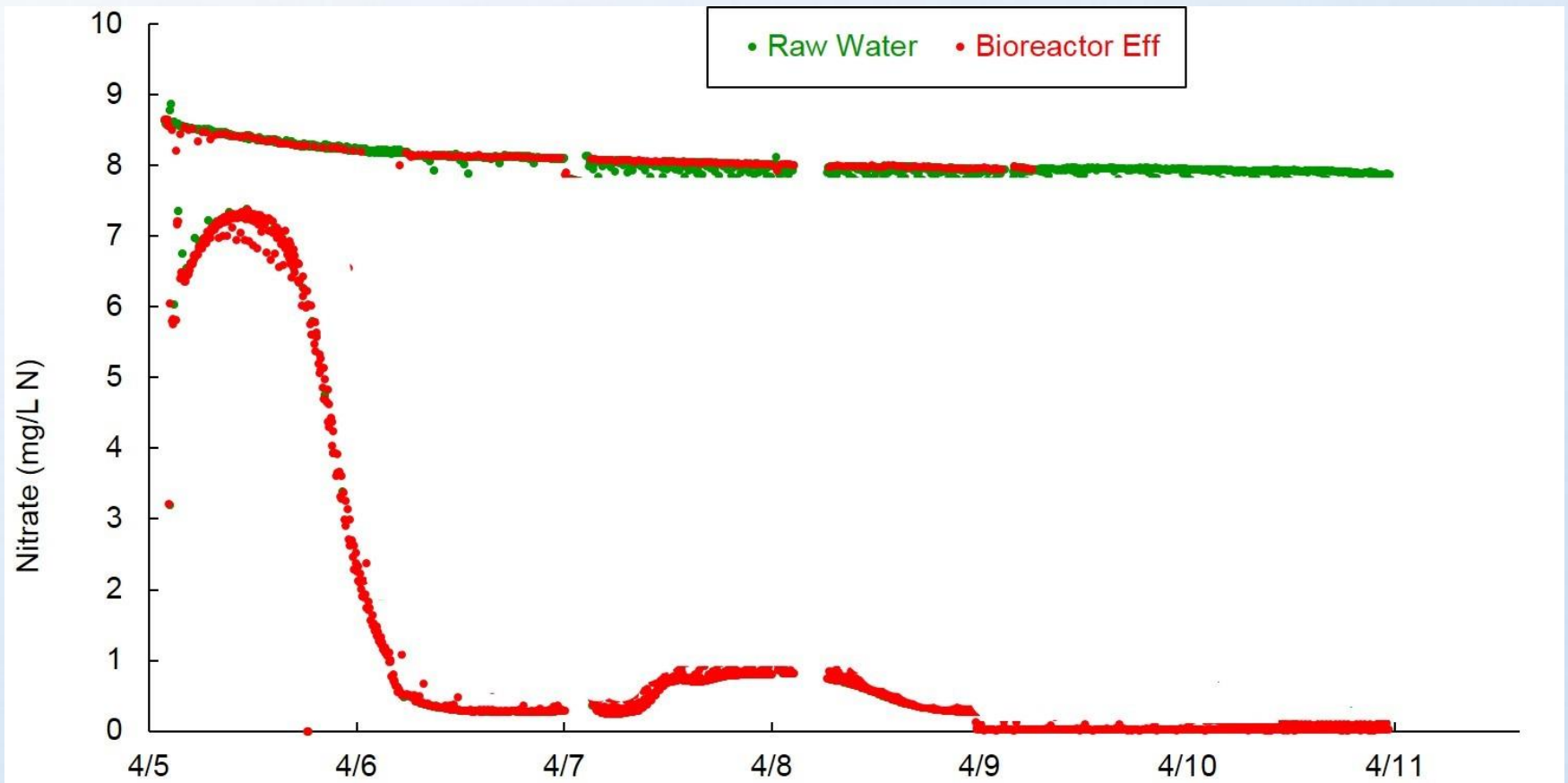
Full-scale System Construction



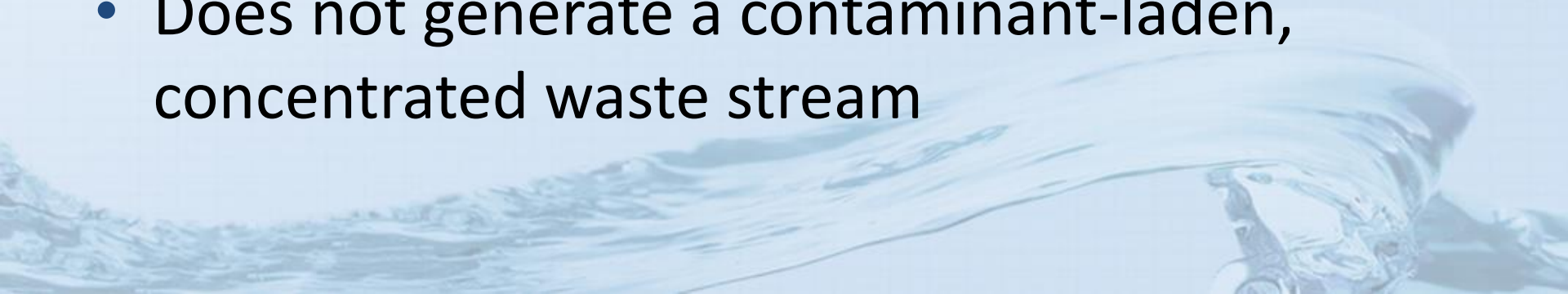
Full-scale System



Complete Nitrate Removal Observed with Full-Scale System



System Performance Summary

- Efficient removal of multiple contaminants can be achieved while avoiding add-on unit processes.
 - System is robust.
 - Design is modular and flexible.
 - Low energy
 - Does not generate a contaminant-laden, concentrated waste stream
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- A decorative graphic at the bottom of the slide showing a splash of clear water with a glass rim visible on the right side.

Acknowledgments

- California Department of Water Resources
- California Division of Drinking Water
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 - Karl Longley, Dan Mount, Jack Safely, Heather Collins
- AdEdge Water Technologies
- PCL Construction





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