To Pilot Test or Not to Pilot Test, That is the Question

Inland Empire WateReuse Chapter Meeting

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Agenda

- What is a Pilot Test?
- Reasons for Pilot Testing
- Types of Testing
- Pilot Test Design
- Pilot Test Operation
- Testing Costs
- Lessons Learned from Case Studies

What is a Pilot Test?

- What is a pilot test and why would we need to discuss it?
- **Pilot Study (***n):* a small-scale experiment or set of observations undertaken to decide how and whether to launch a full-scale project
- This presentation is not about research, it's about implementing an engineering project
- What do I need to know to be sure that I'm making the right decisions?
- Working on a design for a reuse plant and need answers to questions
- Do we need to pilot test?

What is a Pilot Test?

- Researched “Pilot Testing”
  - Learn how to fly an airplane
  - Psychological Testing Plans
  - Buy a car
  - You can even get a University Certificate in pilot testing

Reasons for Pilot Testing

- Why would I want to do a Pilot Test?
  - Regulatory Approval
  - Process Selection & Equipment Qualification
  - Process Validation & Optimization
  - Public Outreach

Reasons for Pilot Testing Regulatory Approval

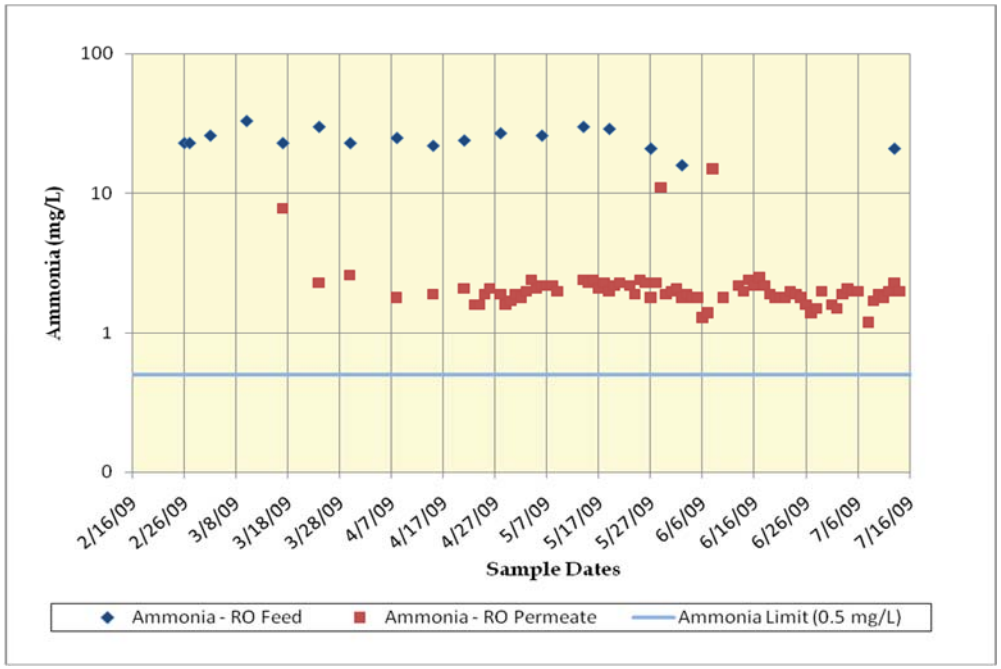
- Florida: FAC 62-610.564
  - Pilot testing is required for all projects that are required to provide full treatment and disinfection
  - To demonstrate the ability of the selected treatment processes to meet the regulatory requirements
  - To evaluate the suitability of the reclaimed water for groundwater recharge or indirect potable reuse
  - The pilot testing shall accumulate 12 months of data
  - Pilot test plan must be submitted for review before testing
- California: Title 22, Division 4. Environmental Health
  - 60320.108 (d) – challenge testing for pathogen reduction
  - 60320.201 – Advanced Treatment Criteria (RO membranes/AOP)
- Texas
  - Requires pilot testing of alternative filtration
  - Wasn't required for Big Spring or Wichita Falls

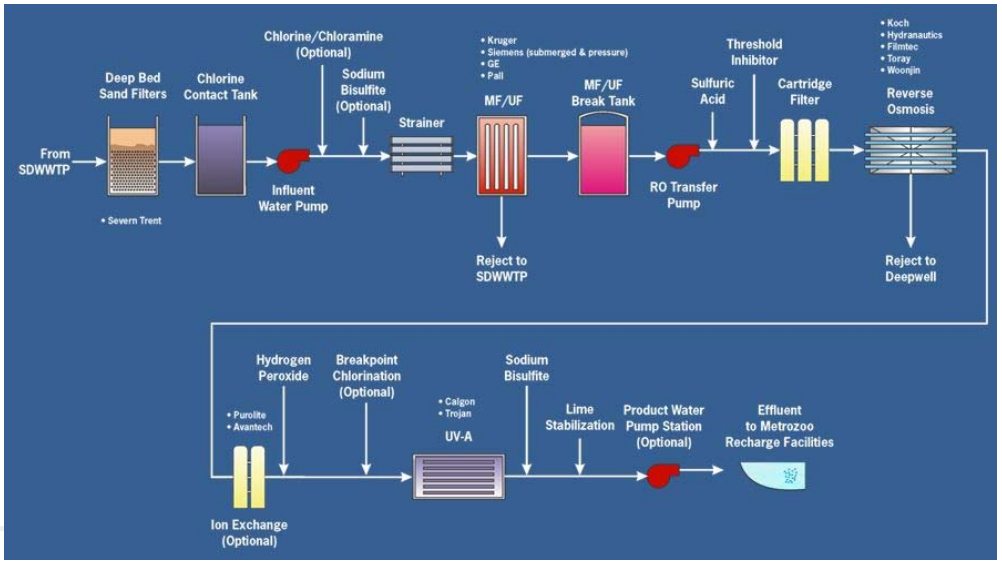
Reasons for Pilot Testing
Process Selection & Equipment Qualification

- Process Selection
  - Does a process works?
  - Side-by-side comparison of different treatment processes
  - Data to determine lifecycle costs
- Equipment Qualification
  - Compare equipment manufacturers
  - Minimum experience qualifications
  - Installed capacity requirements
  - Successfully implemented projects

Reasons for Pilot Testing
Process Validation & Optimization

- Process validation
  - Demonstrate feasibility
  - Define water quality
  - Establish design and operating parameters
- Process Optimization
  - Refine design and operating parameters
  - Reduce lifecycle costs
  - Modify processes to work better (CIPs)





Miami-Dade Pilot Test - Ammonia

Reasons for Pilot Testing
Public Outreach

- Public Outreach
  - Proof of process for use in campaign
  - Give residents a chance to see the processes in action
  - Agencies can craft message on tours
- Public Outreach Considerations
  - Who is the target audience?
  - Who does the tour presentations?
  - Where is the pilot plant located?
  - How simple is the message?
  - Is it a dual purpose facility?
  - What does the pilot test look like?

Reasons for Pilot Testing Examples

Project	Equipment Qualification	Design Criteria	Regulatory Approval	Proof of Process	Process Evaluation	Public Outreach
San Diego	Yes	Yes	Yes	Yes	Yes	Yes
Los Angeles	No	Yes	Yes	Yes	Yes	Yes
JEA	No	Yes	Yes	Yes	Yes	Yes
UOSA	No	Yes	Yes	Yes	Yes	No
Hampton Roads	No	Yes	Yes	Yes	Yes	Yes
SDWRP	Yes	Yes	Yes	Yes	Yes	No
Las Virgenes	Yes	Yes	Yes	Yes	Yes	Yes
LVLWTF	No	Yes	No	Yes	No	No
Beenyup	No	Yes	Yes	Yes	Yes	Yes
EMWD	No	Yes	No	Yes	No	Yes

Types of Pilot Testing

- Bench scale testing
- Pilot testing
- Demonstration testing
- Full scale testing

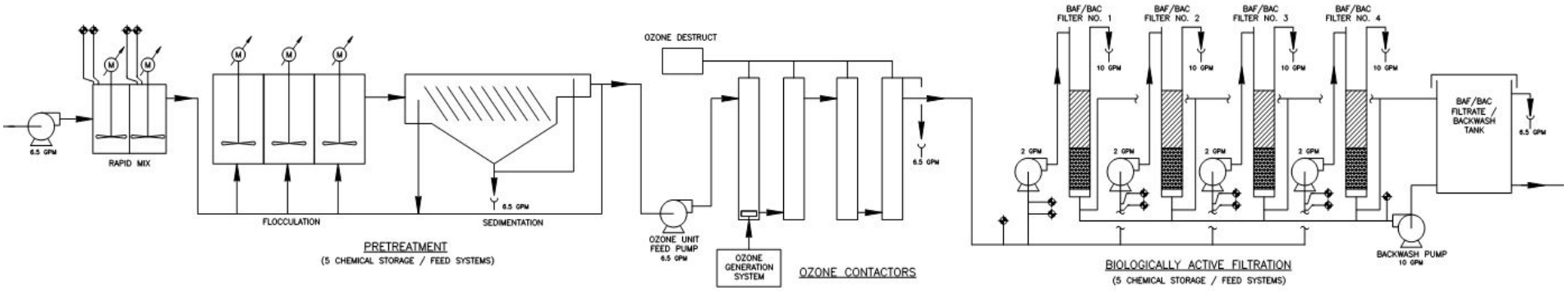
Pilot Test Design

- Design& Process Selection
- Site Planning
- Test Protocol

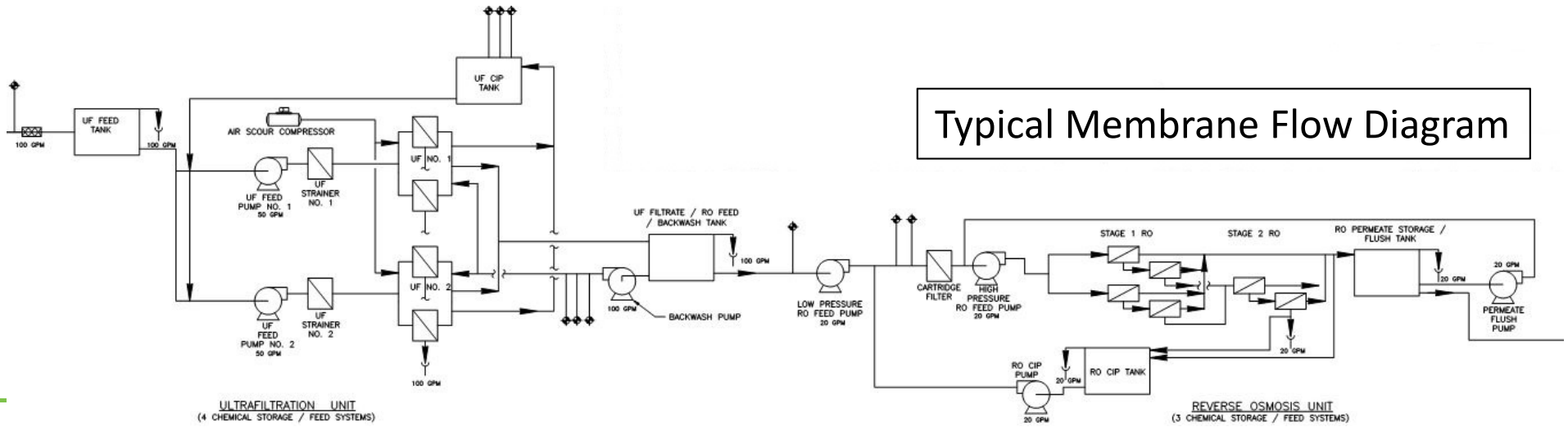
Pilot Test Design
Process Design and Selection

- Process system flow diagram
- Capacity/flows
- Source water

Typical Ozone-BAF Flow Diagram

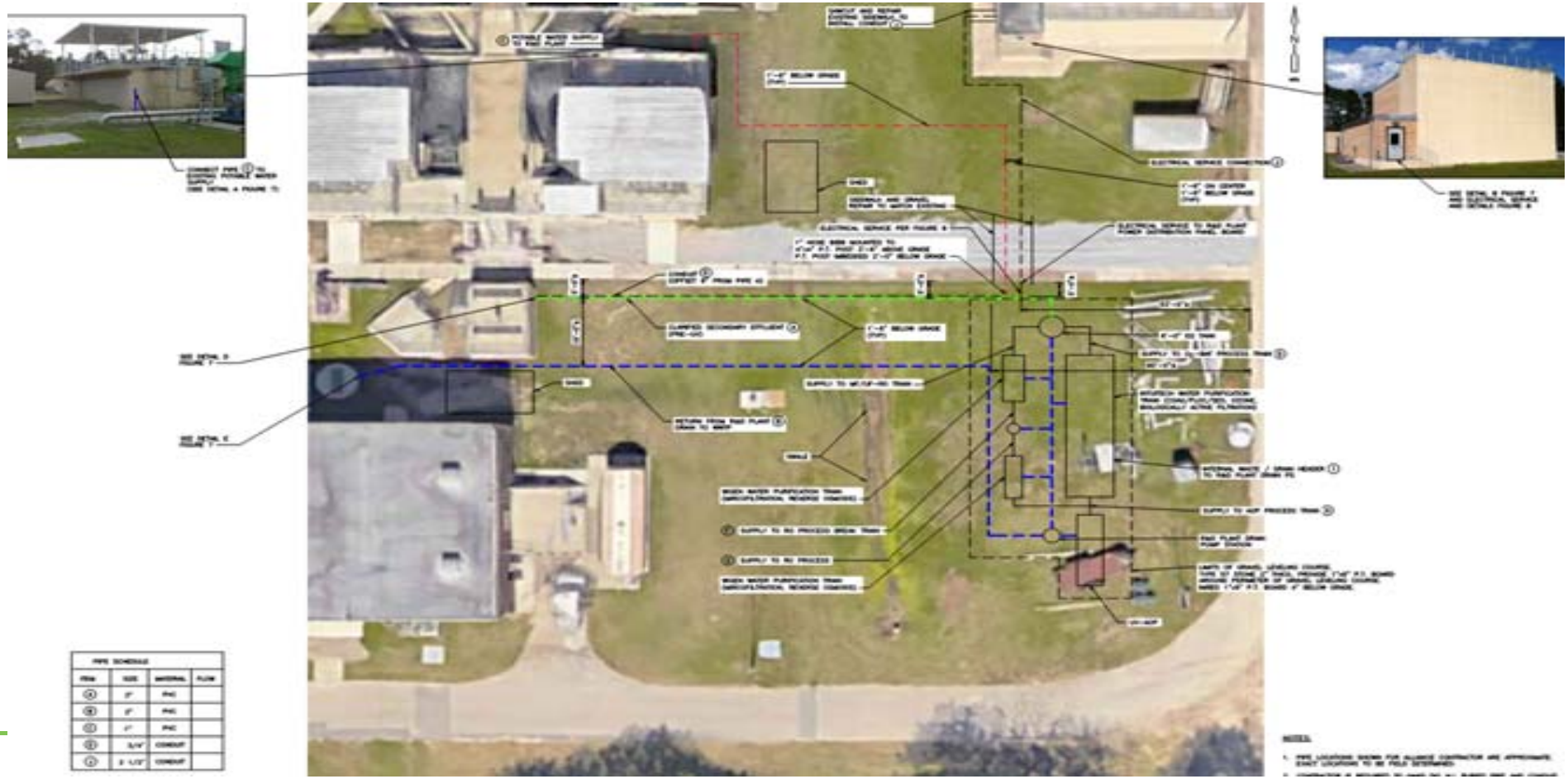


Typical Membrane Flow Diagram



Pilot Test Design
Site Planning

- Location
- Waste management
- Security

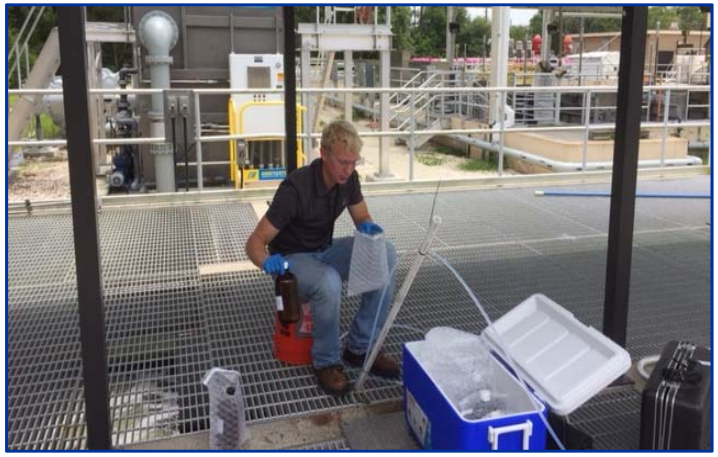


Pilot Test Design
Test Protocols – Test Plan

1) Define the program goals
2) Consider alternatives
3) Identify key issues and requirements
4) Prepare preliminary cost estimates
5) Develop detailed test protocol
6) Prepare thorough design
7) Contingencies for potential problems
8) Quality construction
9) Retain experienced operators
10) Documentation requirements

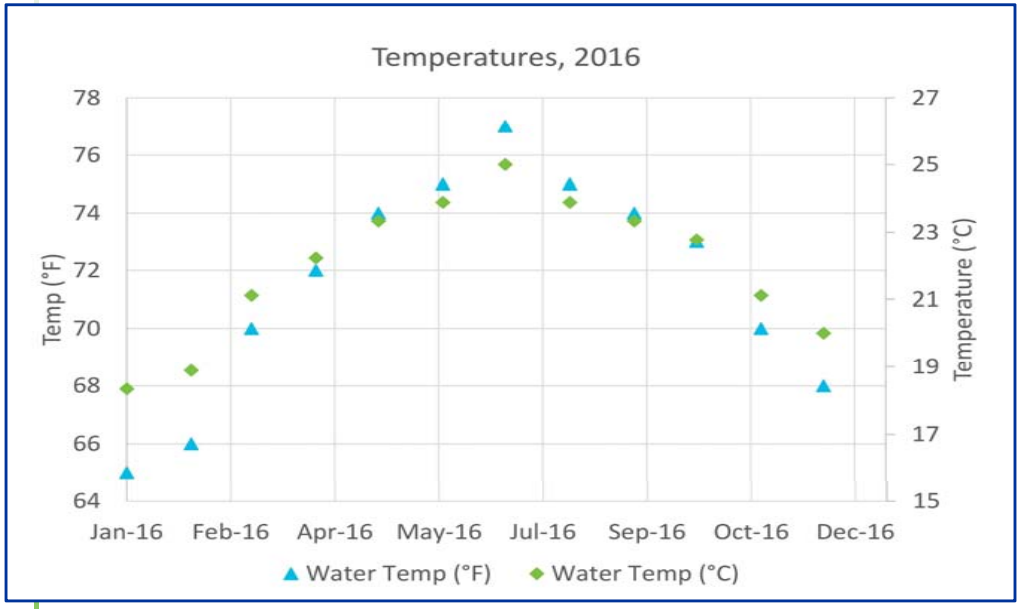
Pilot Test Design
Test Protocol - Other Considerations

- Define responsibilities
  - Agency – site, source water, power
  - Consultant – design, operate, troubleshooting, interpretation, reporting
  - Vendor – equipment, training, optimize
  - Contractor – demolition, construction
- Equipment procurement
- Water quality sampling/testing
  - Consultant vs lab vs agency
- Safety – operators, equipment protection
- Process criteria – operating conditions
- Sampling locations



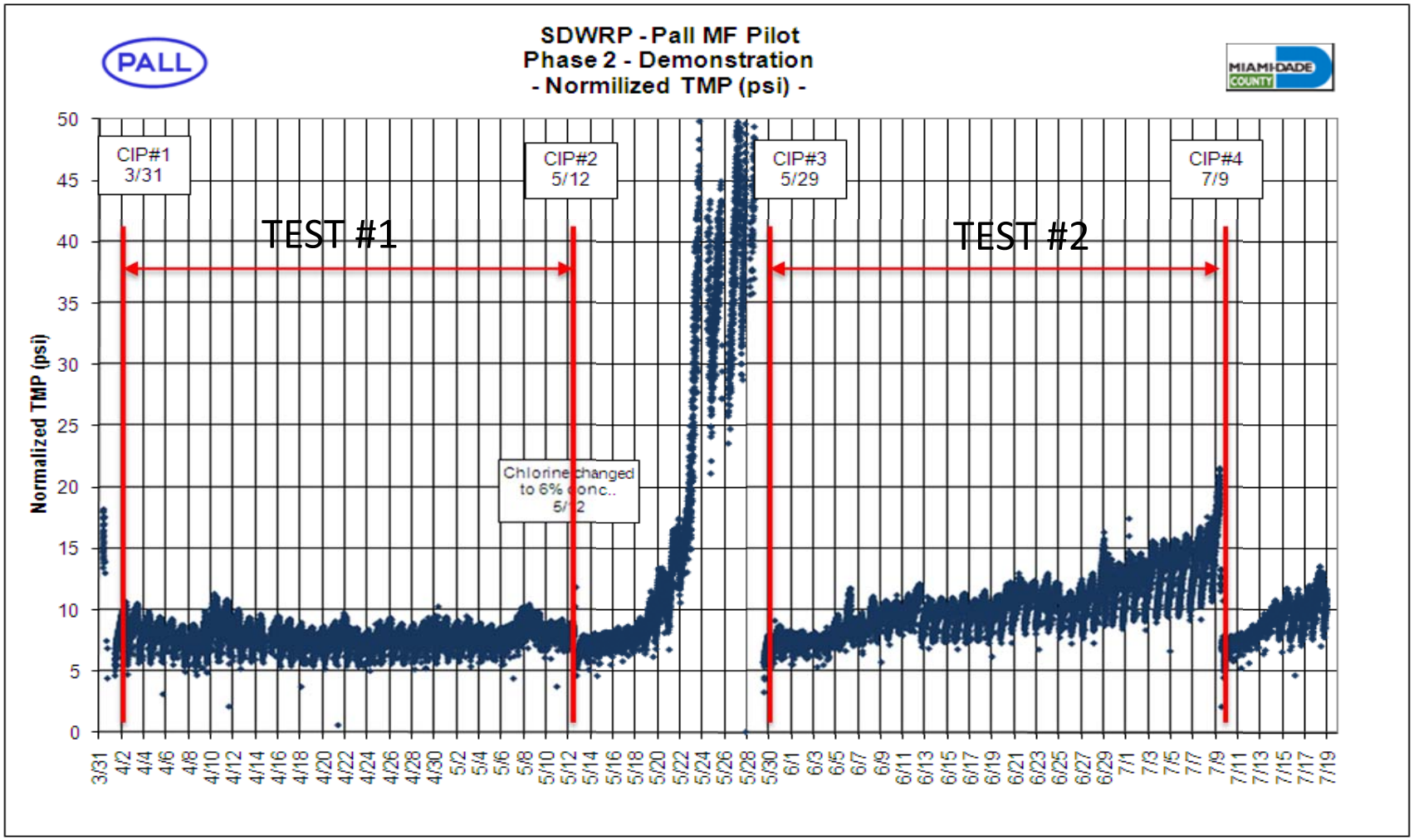
Pilot Test Operation
Length of Test

- Regulatory requirements
- Seasonal variations
- Multiple cleaning cycles
- Available budget
- Obtain stable operation
- Obtain data
- Process optimization



Examples
JEA – warm/wet & cool/dry seasons
GWRS - 8,000 hours for RO membrane qual
Florida Regulations - 12 months
LVMWD – 3 to 5 years for public outreach
LVLWTF – UV/chlorine (2 days)
MWD – 12 months
MDWASD - Two 40-day MF cleaning cycles

Pilot Test Operation
Length of Test



Pilot Test Operation
Source Water & Operation

- Source water
  - Secondary effluent
  - Tertiary effluent
  - Is source easily accessible?
- Operator experience
  - Staff engineers or grad students
    - Eager to learn/engaged
    - Less expensive
    - More time onsite
    - Valuable learning experience
  - Experienced operators
    - Understand the processes better
    - Identify/solve problems
    - Less oversight required

Pilot Test Operation
Process Monitoring - Membranes

Process	Water Quality	System Operation Criteria	
MF	Turbidity TSS Pathogen reduction Compare membranes	Flows Flux Recovery TMP	Membrane integrity Fouling Optimize CIP Filter Efficiency
RO	Conductivity TOC Pathogen reduction CEC removal Salt rejection	Flows Flux Recovery Number of stages	ΔP Fouling/CIP Trasar
Disinfection AOP	Pathogen removal CEC reduction Surrogate compounds	Flows Power UVT	Chemical use Alternative oxidants Residual disinfectant
Other	Product water stabilization	Chemical selection Chemical use	

Pilot Test Operation
Process Monitoring - Ozone-BAF

Process	Water Quality	System Operation Criteria	
Ozone	Ozone demand Bromate formation NDMA formation Pathogen reduction	Ozone dose Contact time pH Ozone/DOC ratio	
BAF	TOC CECs Turbidity	Loading rate EBCT Filter media types Run time	Backwash strategy Coagulant dose Headloss
Disinfection	Pathogen removal	UVT/Power Chlorine/chloramine	

Pilot Test Operation
Data Collection

- What data is needed?
- How will the data be recorded?
- How much data is too much?
- Data QAQC procedures

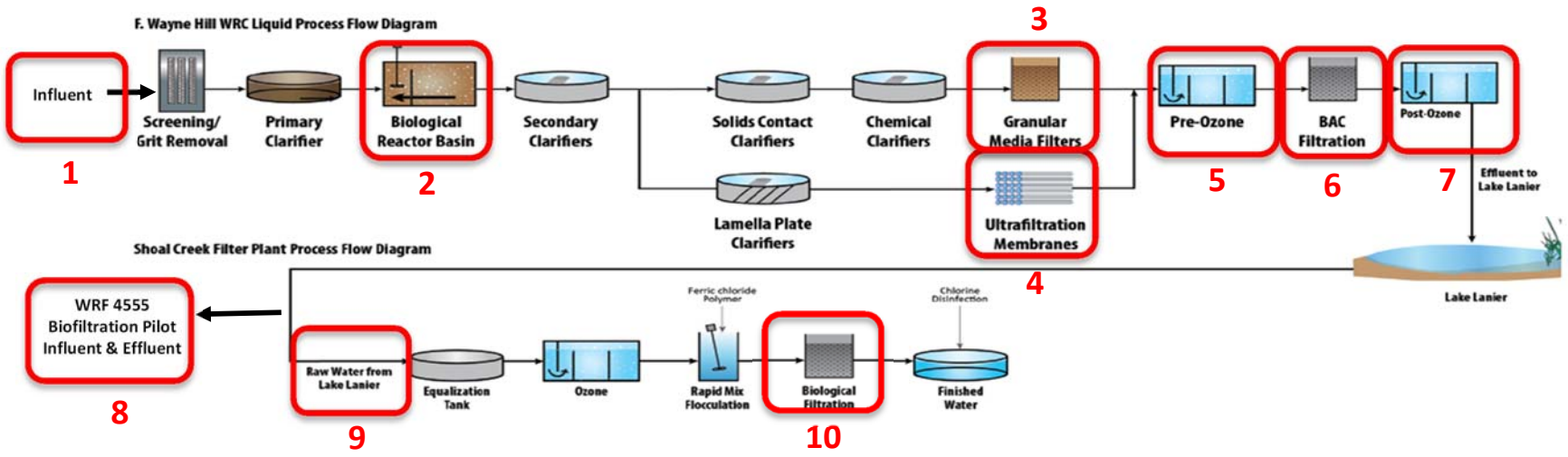
Manual Recording	Continuous Data
Requires operator to take measurements	Accurate when calibrated correctly
Not all parameters have on-line monitors	Doesn't require an operator onsite
Operators are more involved in the test	Instruments are more expensive
Good documentation control is required	Lots of digital data
	Easy to review & manipulate

Pilot Test Operation
Example Sampling Matrix - Parameters

Parameter	Influent	Ozone Effluent	Coag/Flocc Effluent	Biofilter Effluent	Biofilter Media	Finished Water	Backwash Water
Biological Indicators	●		●	●	●	●	
Organic Characteristics	●	●	●	●		●	
Trace Chemical Constituents	●					●	
DBPs/DBP-FP	●	●		●		●	
General Water Quality	●	●	●	●		●	●
Inorganic Chemicals						●	
Operational Parameters	●	●	●	●	●	●	●

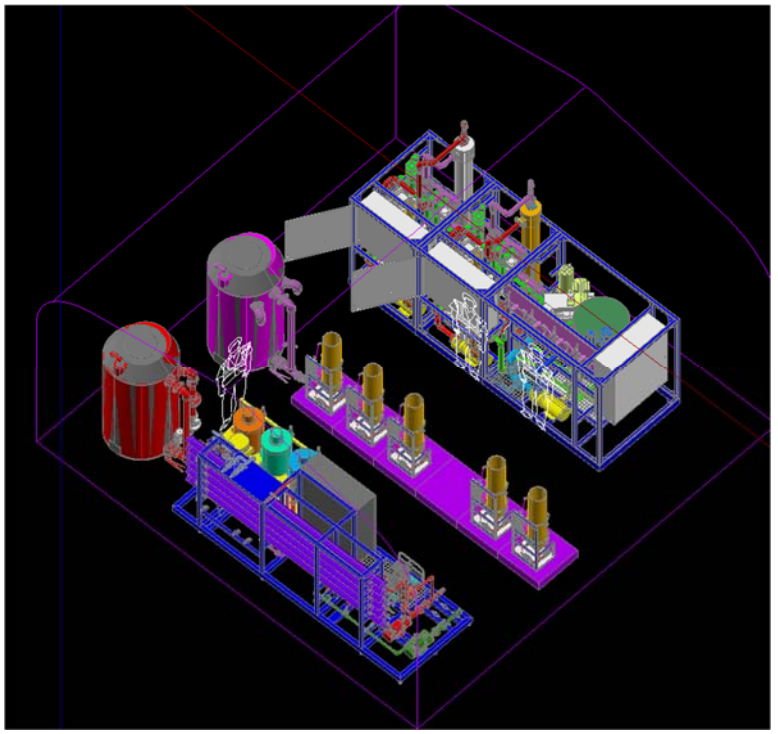
Pilot Test Operation
Example Sampling Matrix - Locations

Parameter	Location ID									
	1	2	3	4	5	6	7	8	9	10
Biological Indicators	●		●	●		●	●	●	●	●
Organics	●		●	●	●	●	●	●	●	
Trace Constituents	●				●	●	●	●	●	
DBPs/DBE-FP	●		●	●	●	●	●	●	●	
General Water Quality	●	●	●	●	●	●	●	●	●	
Inorganic Chemicals	●	●	●	●			●	●	●	
Operational Parameters	●	●	●	●	●	●	●	●	●	●



Costs of Pilot Testing

- Test systems can be obtained from:
  - Vendors
  - Test equipment manufacturers
  - Consultants
  - Agencies



Costs of Pilot Testing

- Procurement Methods
  - Rent or Lease (< 6 months)
  - Purchase (> 12-18 months)
  - Vendor supply (free or lease)
- Water quality tests
  - Standard WQ
  - CECs
  - Other
- WQ Cost Considerations
  - Budget
  - CECs are most expensive
  - Frequency of Testing
  - Duplicate Samples

System	Lease (18 months)	Purchase (5 years +)
UF Skid	$203,000	$265,000
RO Skid	$345,000	$260,000
UV Unit	$72,000	$120,000
Total	$620,000	$645,000

Costs of Pilot Testing

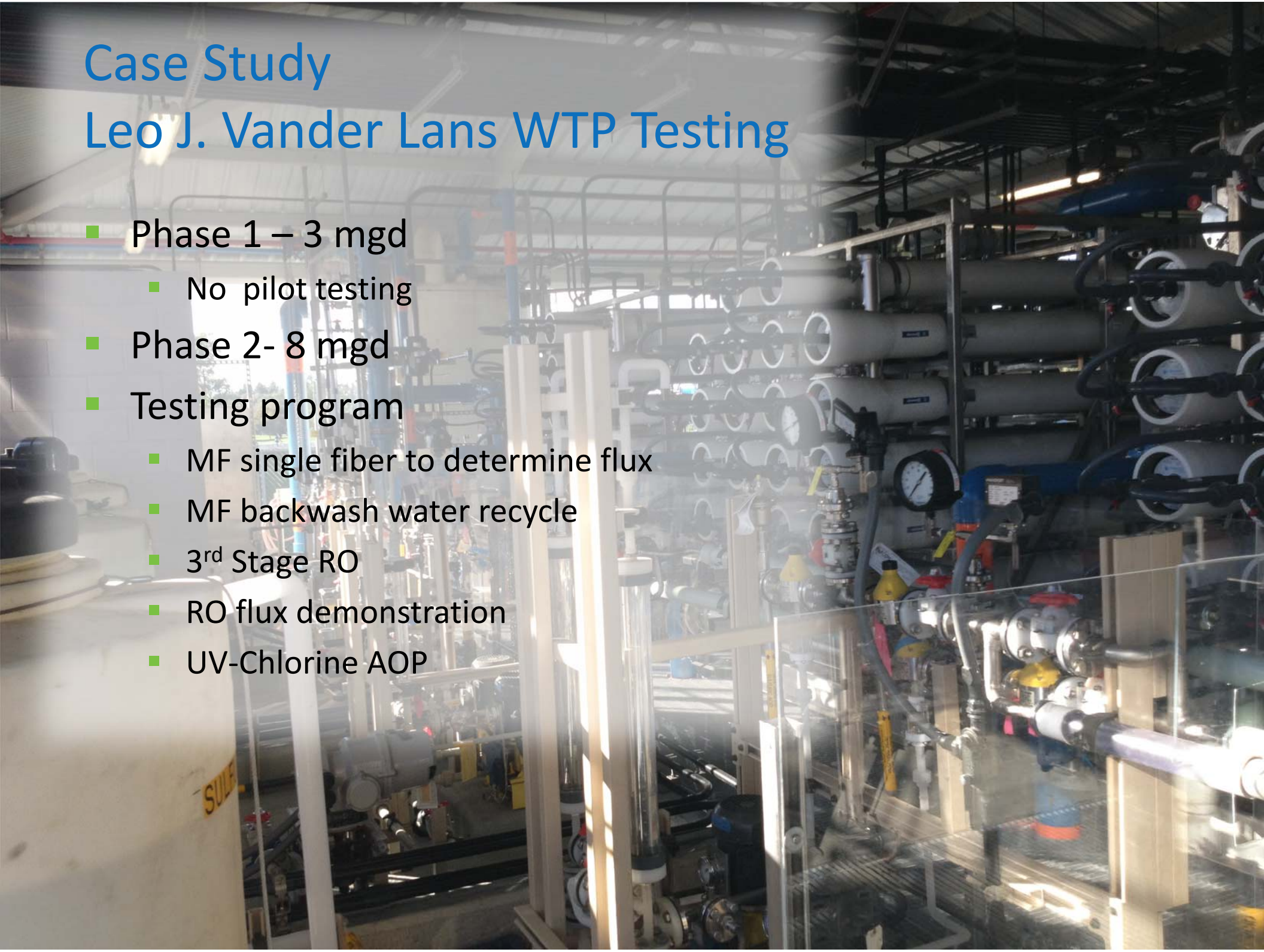
- Cost vs Benefit
  - Small project – searching for fatal flaws
  - Large project - better chance for significant savings
- Risk
  - Higher risk means more benefit to pilot
    - Poor water quality (variability, polymers)
    - New processes (3rd stage RO, proprietary)
  - Conservative design criteria can increase costs
  - Fouling – fatal flaw, CIP methodology, lifecycle costs


GWRS

Costs of Pilot Testing

Plant	Process	Flow Rate (gpm)	Duration (mos)	Eq. Cost ($M)	Analytical Costs ($M)	Design & Operation ($M)	Total Costs ($M)
1	MF/RO/UV-AOP	100	2	0.4	1.0	0.9	2.3
2	MF/RO/UV-AOP	700	18	3.7	0.6	2.3	6.6
3	O_3-BAF	10	18	0.3	0.2	0.7	1.2
4	O_3-BAF	5	18	0.9	0.4	1.4	2.7
5	MF/RO/UV-AOP	20	16	0.6	0.3	1.1	2.0
6	MF/O_3-BAF/AOP	20-50	6	0.8	0.7	1.0	2.5
7	O_3-BAF MF/RO/UV-AOP	8 100	18	0.8	0.6	1.0	2.4
8	MF/RO/UV-AOP	20	2	.04	NA	0.09	0.13

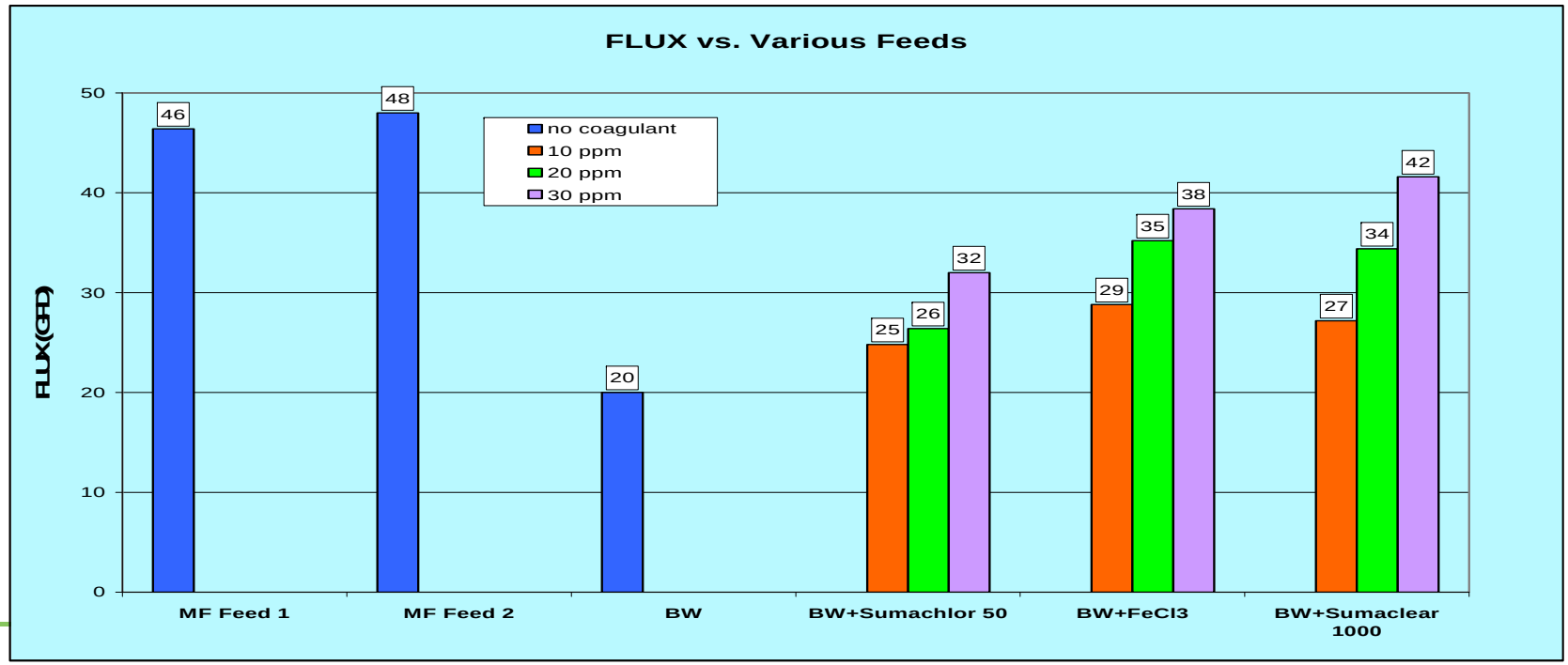
Case Study
Leo J. Vander Lans WTP Testing



- Phase 1 – 3 mgd
  - No pilot testing
- Phase 2- 8 mgd
- Testing program
  - MF single fiber to determine flux
  - MF backwash water recycle
  - 3rd Stage RO
  - RO flux demonstration
  - UV-Chlorine AOP

WRD Vander Lans WTP Testing
MF Backwash Treatment System

- MF Flux (inst/avg)
  - Single fiber testing
  - Expansion – 31/25 gfd
  - MF Backwash – 24/18 gfd
- MF backwash water treatment
  - Jar tests – solids didn't settle
  - Vendor bench scale tests - DAF with 30-50 mg/L ferric chloride

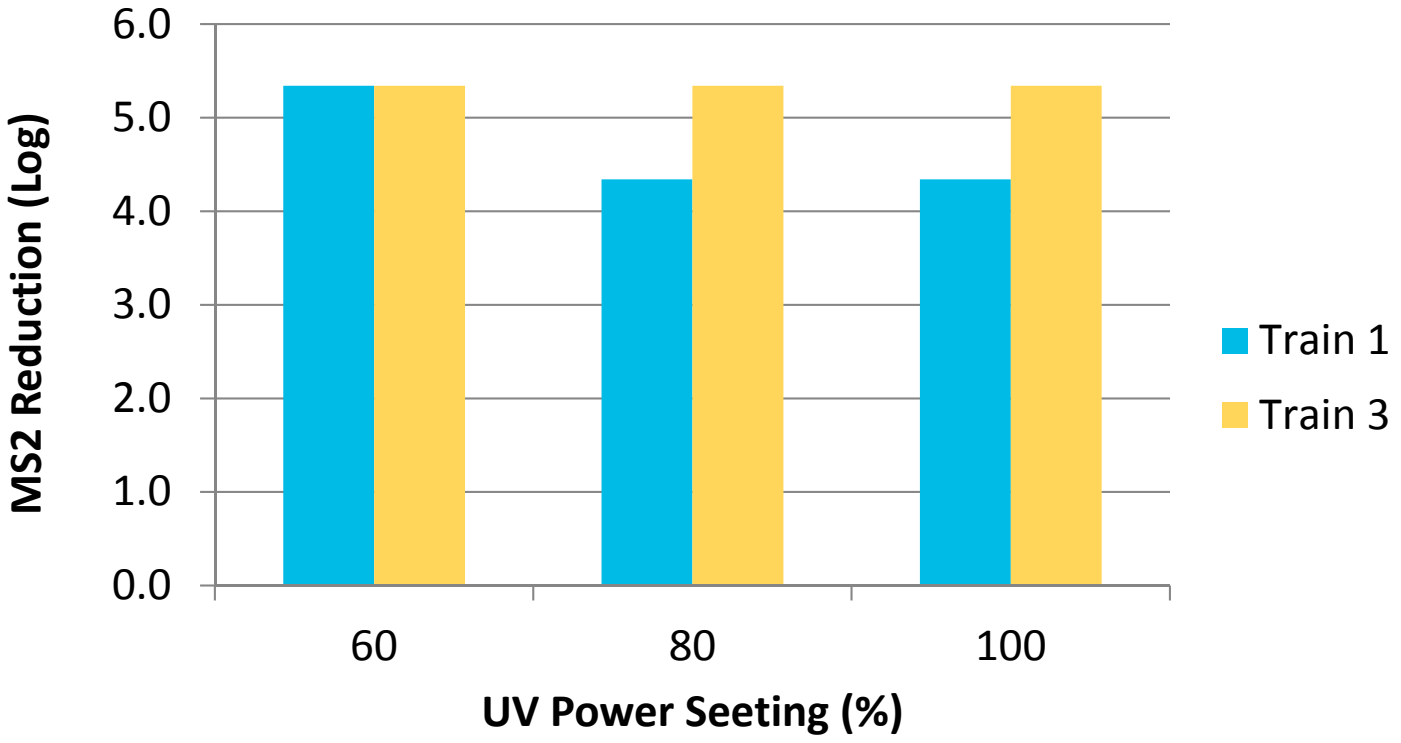


WRD Vander Lans WTP Pilot Testing
3rd Stage RO Pilot Testing

- Pilot testing conducted on "sacrificial third stage" to achieve 92.5% recovery
- Tested for 2 months
- Required 2-3 week cleaning cycles for 3rd stage
- Acid/base cleaning as effective at recovering flux as proprietary cleaners
- Operated 2 years without 3rd stage CIP
- RO flux increase demonstration on full scale (10 gfd to 12.2 gfd)

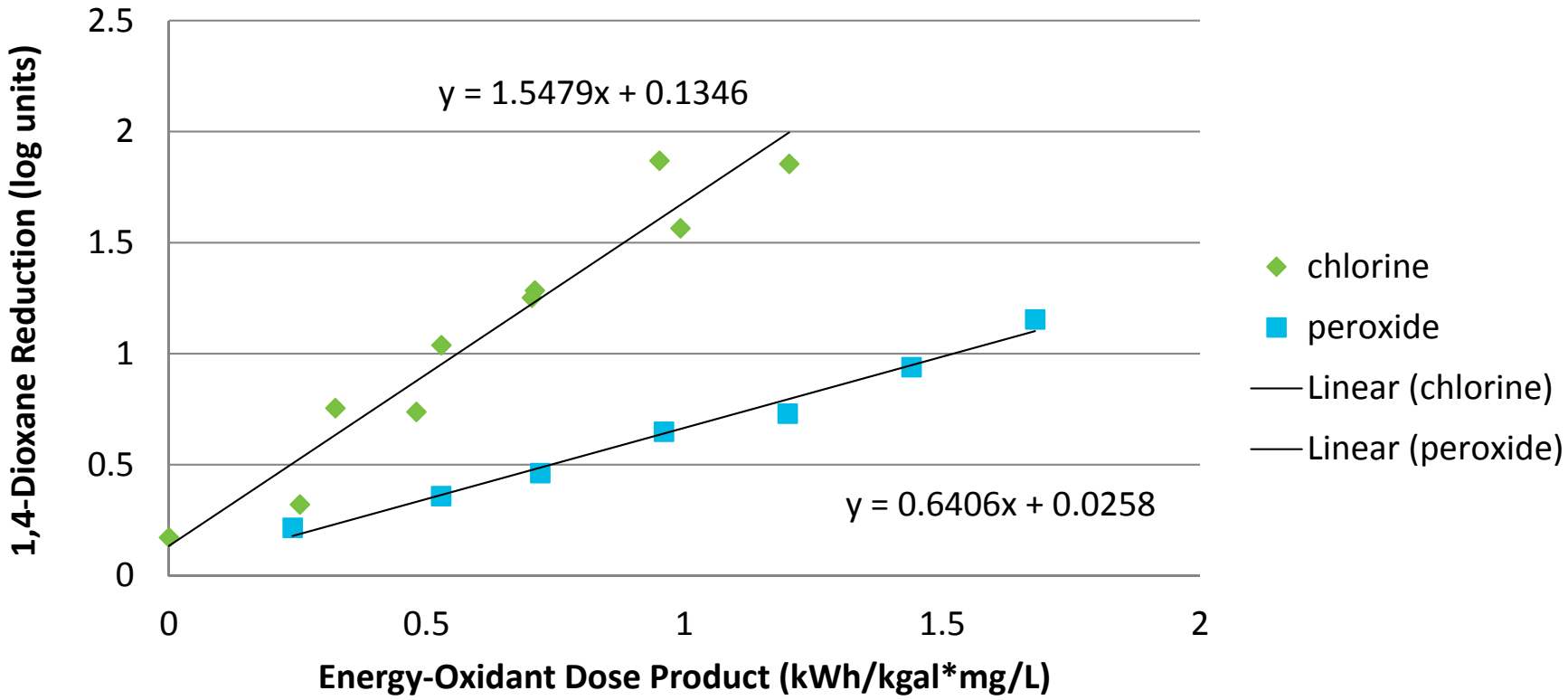
WRD Vander Lans WTP Testing
UV Challenge Testing

- Demonstrate 6-log reduction of virus, *Giardia*, and *Crypto*
- Full-scale demonstration showed >6-log reduction when operated at or above 60% power setting



WRD Vander Lans WTP Testing
UV Chlorine AOP

- Demonstrated 0.5-log 1,4-dioxane reduction with UV/chlorine at 0.24 kWh/kgal*mg/L
- Could allow 67% reduction in either oxidant dose

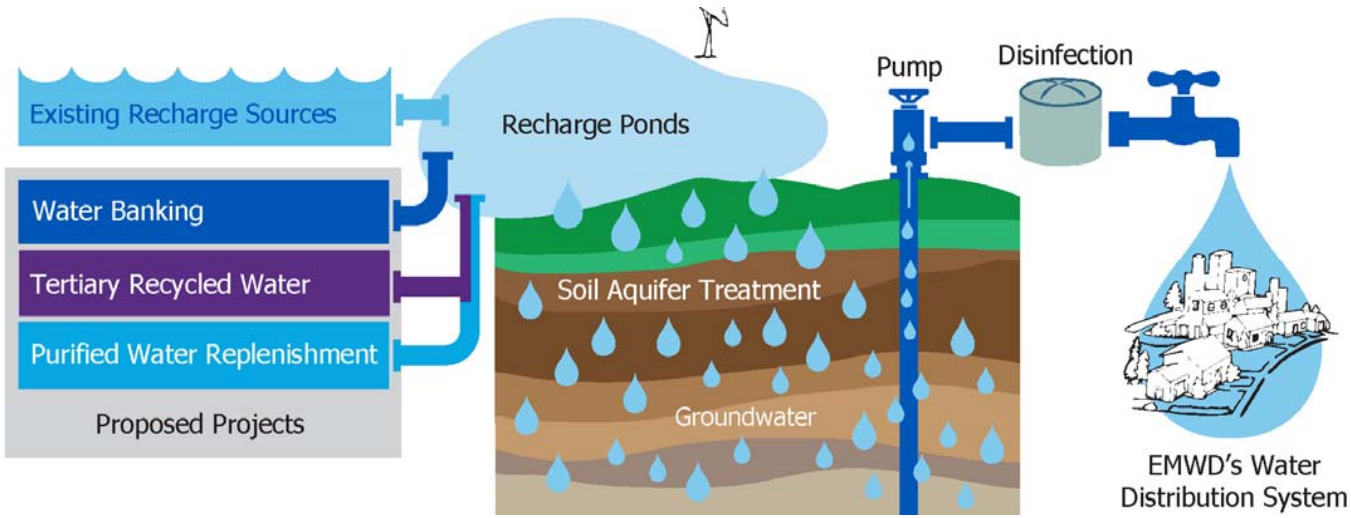


Case Study EMWD

GROUNDWATER RELIABILITY PLUS
Securing Our Water Future

- MF/RO for TDS & TOC reduction
- Capacity - 1.5mgd (Ph1) to 7.5 mgd (Ph2)
- Pilot Testing
  - Public outreach
  - Design criteria
  - Location
  - When

- Input into the Design
  - Source water selection (SE vs TE)
    - MF fouling at other projects
    - SE has solids polymers
    - TE has filter aid polymers
  - Optimize MF flux rate
  - Secondary RO confirmation



Summary

- The goal of a project is to meet the needs of the community
- Testing can be a part of the implementation process
- It's a team effort between the agency, consultant, vendor, contractor, regulators
- Pilot testing isn't required, but it can be helpful
- Testing isn't only experimentation and can accomplish multiple purposes (fatal flaw, design criteria, OP experience)
- Tests should be designed to get the information that is needed
- Capacity of the test isn't as important as what is being tested
- Pilot testing can be expensive while saving money at the same time


Questions