FUTURE SUPPLY ACTIONS PROGRAM
WEBINAR SERIES

Thousand Oaks
Groundwater Utilization Study

July 22, 2021

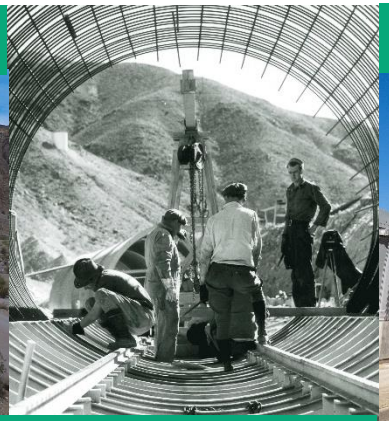
Agenda

The Metropolitan Water District of Southern California

- Nation's largest wholesale water provider
- Service area: 19 million people/5,200 square miles/parts of six counties
- 26 member agencies
- Supports $1 trillion regional economy
- Imports water from Northern Sierra and the Colorado River, invests in local projects

Metropolitan's Role for Southern CA

REGIONAL PROVIDER

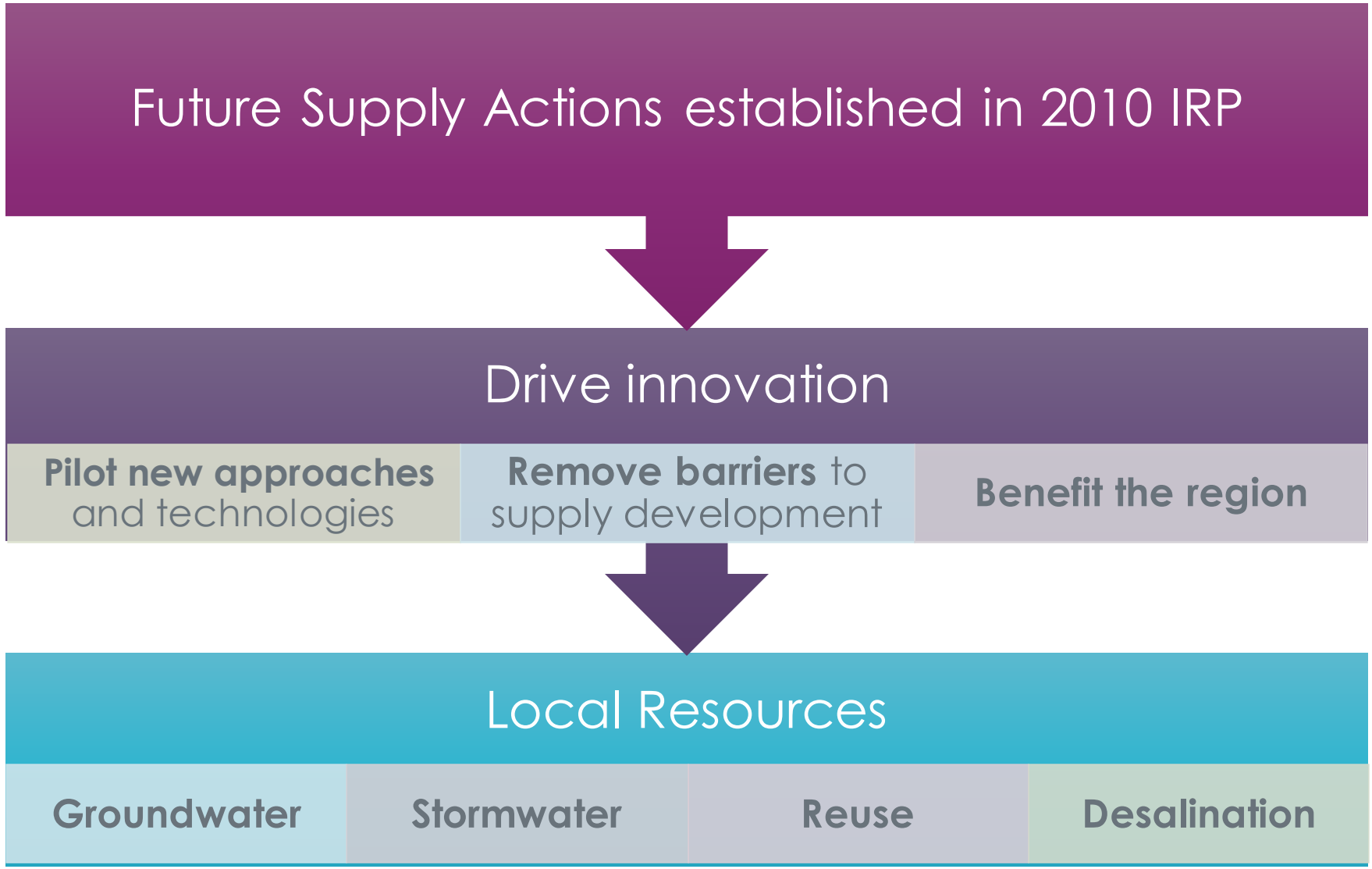


INNOVATION

VISION

SAFE & RELIABLE

Future Supply Actions Funding Program



Current Program

Member Agency

- 14 studies
- $3.1 million

Water Research Foundation

- 6 potable reuse studies
- 1 agricultural reuse study
- $975k

Speaker Spotlight

Ayda Forouzan, P.E.

Associate Engineer

City of Thousand Oaks, Public Works Department

Steven M. Diamond, P.E.

Senior Project Manager/Water Treatment

Kennedy Jenks

Developing a local source of water supply

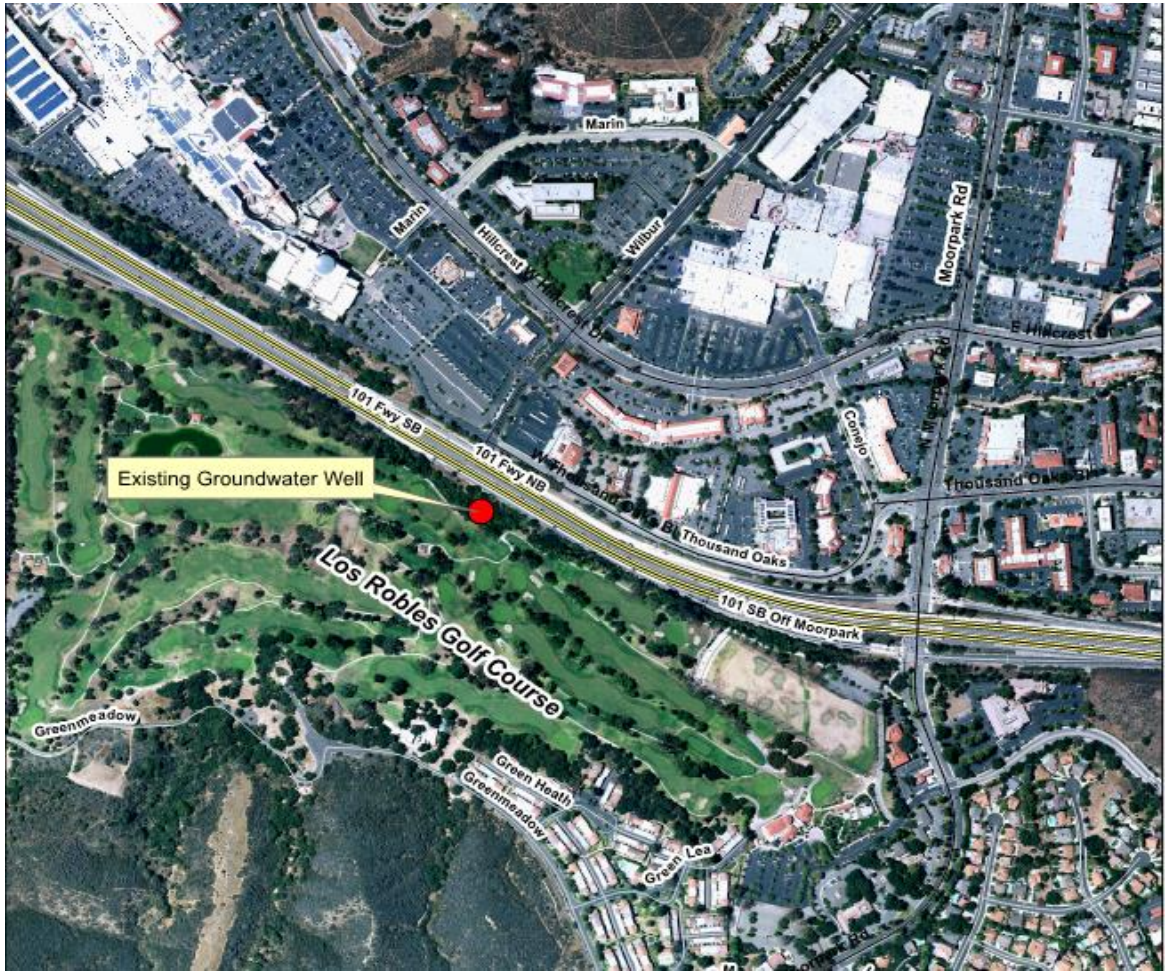
City of Thousand Oaks currently relies 100% on imported water

<u>Project drivers:</u>

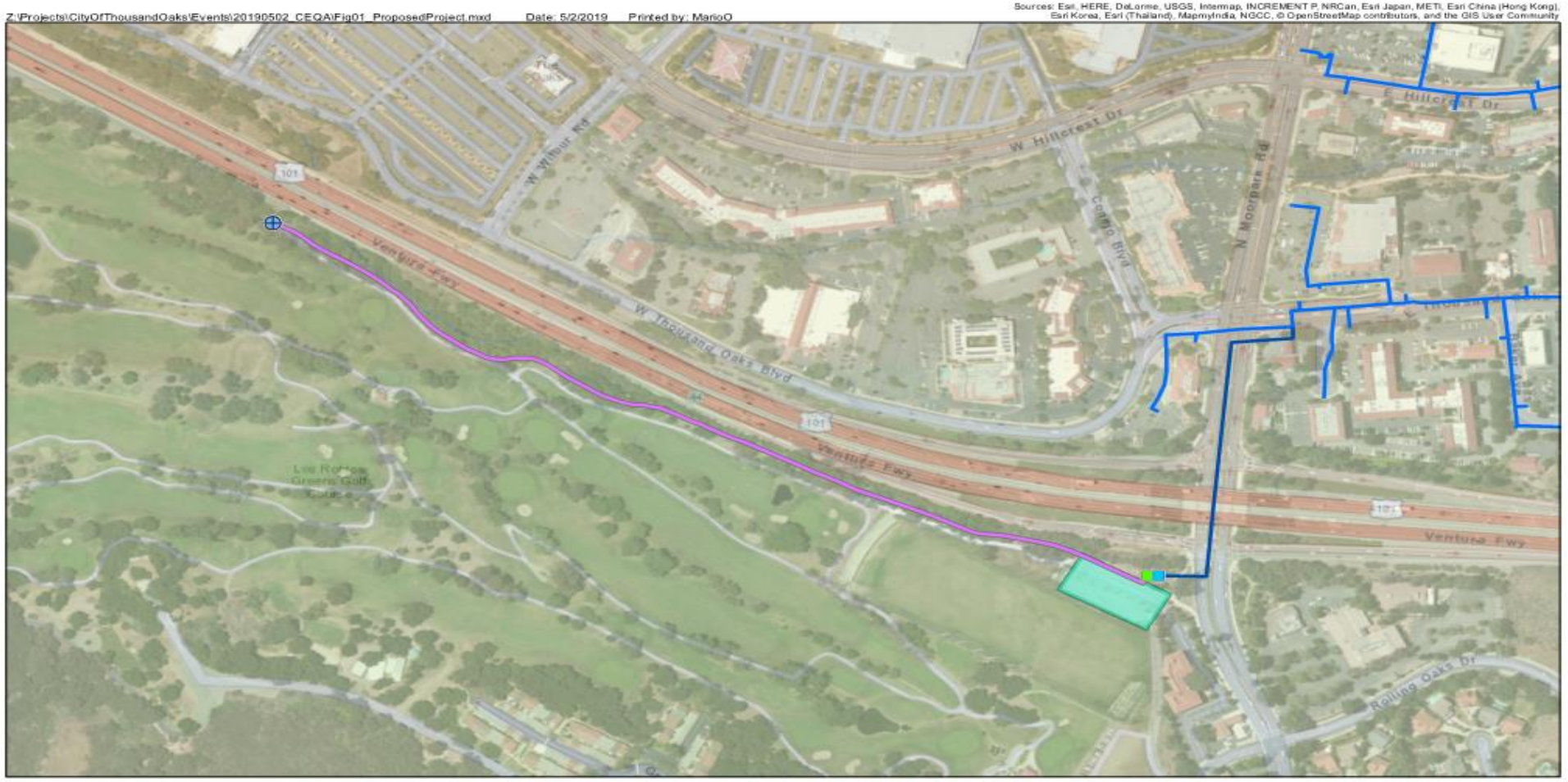
- Increasing cost of imported water
- Reliability of imported water supplies is threatened

Project Overview

- 2016 Thousand Oaks Groundwater and Reclaimed Water Study
- 2018 Initial (Feasibility) Study
- 2018/2019 Draft PDR – Developed Initial Design Criteria
- 2019 Pilot Testing
- 2020/2021 Extended Pumping Test
- 2020/2021 CEQA/MND
- 2021 Final PDR



Project Layout



Legend

Facilities

- Potable Water Pump Station
- Irrigation Water Pump Station
- Well Site (Existing)
- WTP (Proposed)

Pipelines

- Thousand Oaks (Existing)
- Potable Water Transmission Pipeline
- Irrigation and Raw Water Pipelines (Proposed)

N

0 200 400

Scale: Feet

Kennedy/Jenks Consultants

LRGC Groundwater Utilization Project
City Of Thousand Oaks

May 2019
Project Map
Figure 2

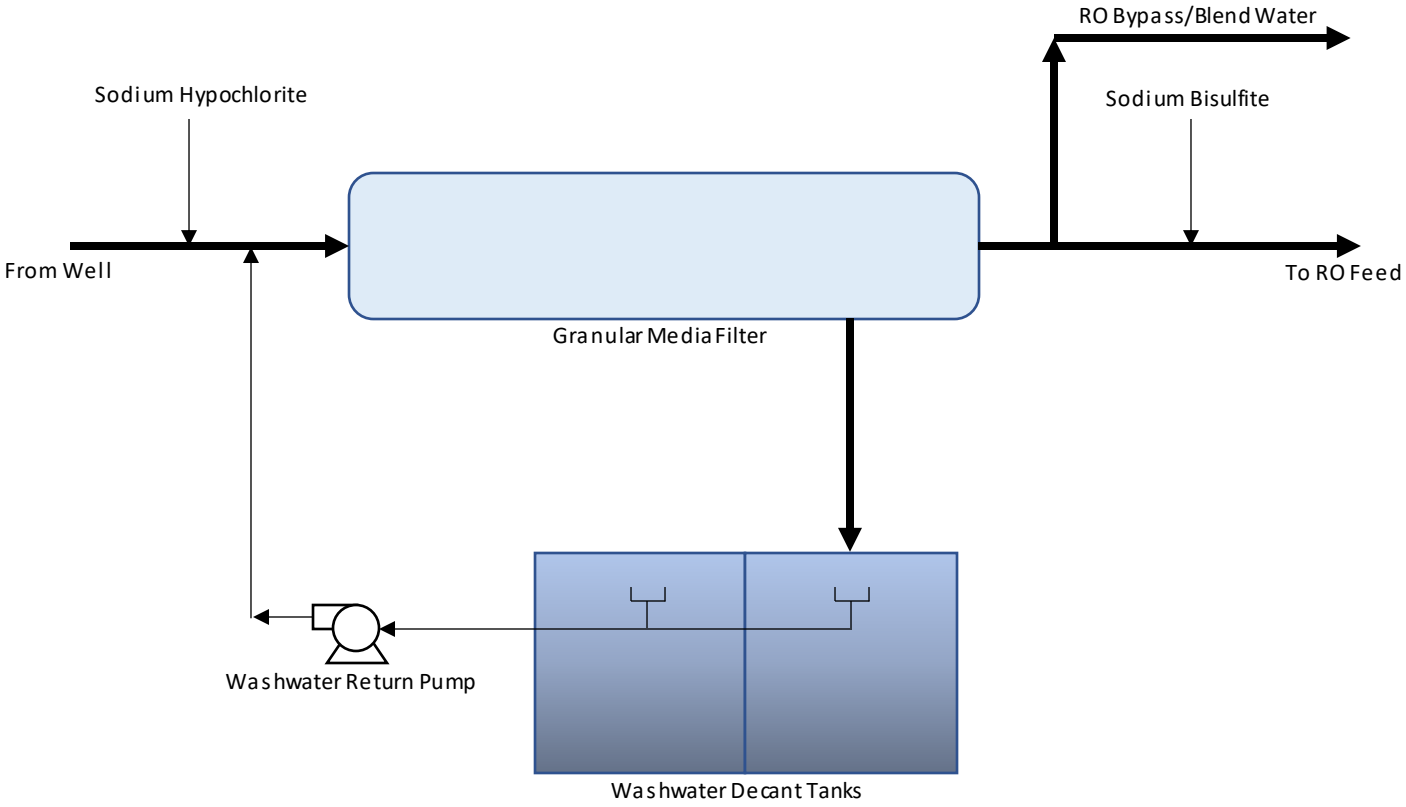
Pilot Testing Objectives

- Refine design raw water quality and design criteria for key unit processes (Fe/Mn Pretreatment, RO, CCRO).
- Optimize performance of treatment trains
- Optimize O&M requirements
- Provide City with operational experience

Pilot System Design: Pre-Treatment

Pre-Treatment Requirements:

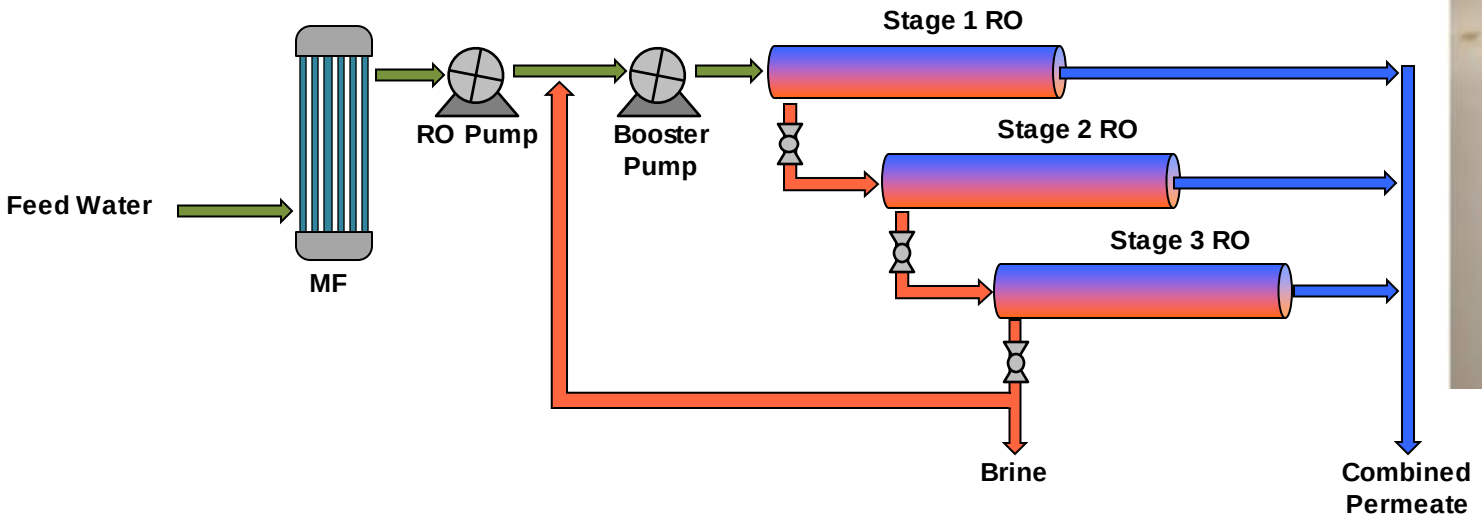
- Iron Removal or sequestering
- Oxidation/Filtration



Pilot System Design: Conventional RO

Conventional Reverse Osmosis (RO):

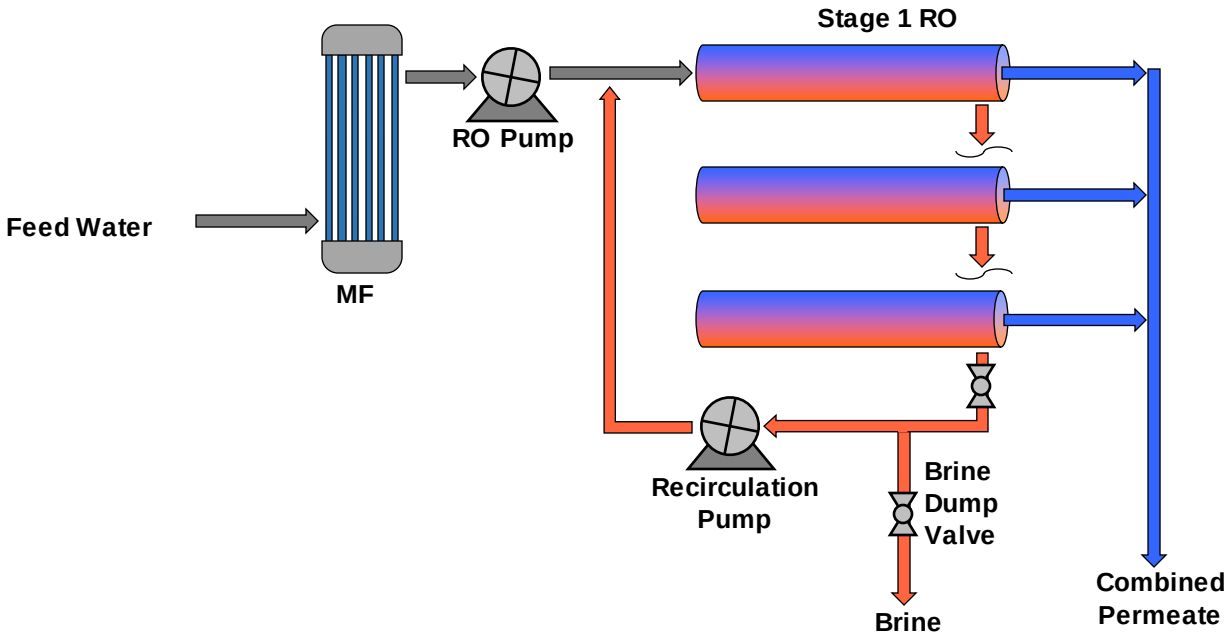
- Pressure Driven membrane process.
- Boosts feed water pressure to exceed osmotic pressure of water.
- Require iron pretreatment, cartridge filtration, and scale conditioning (scale inhibitor and pH adjustment).

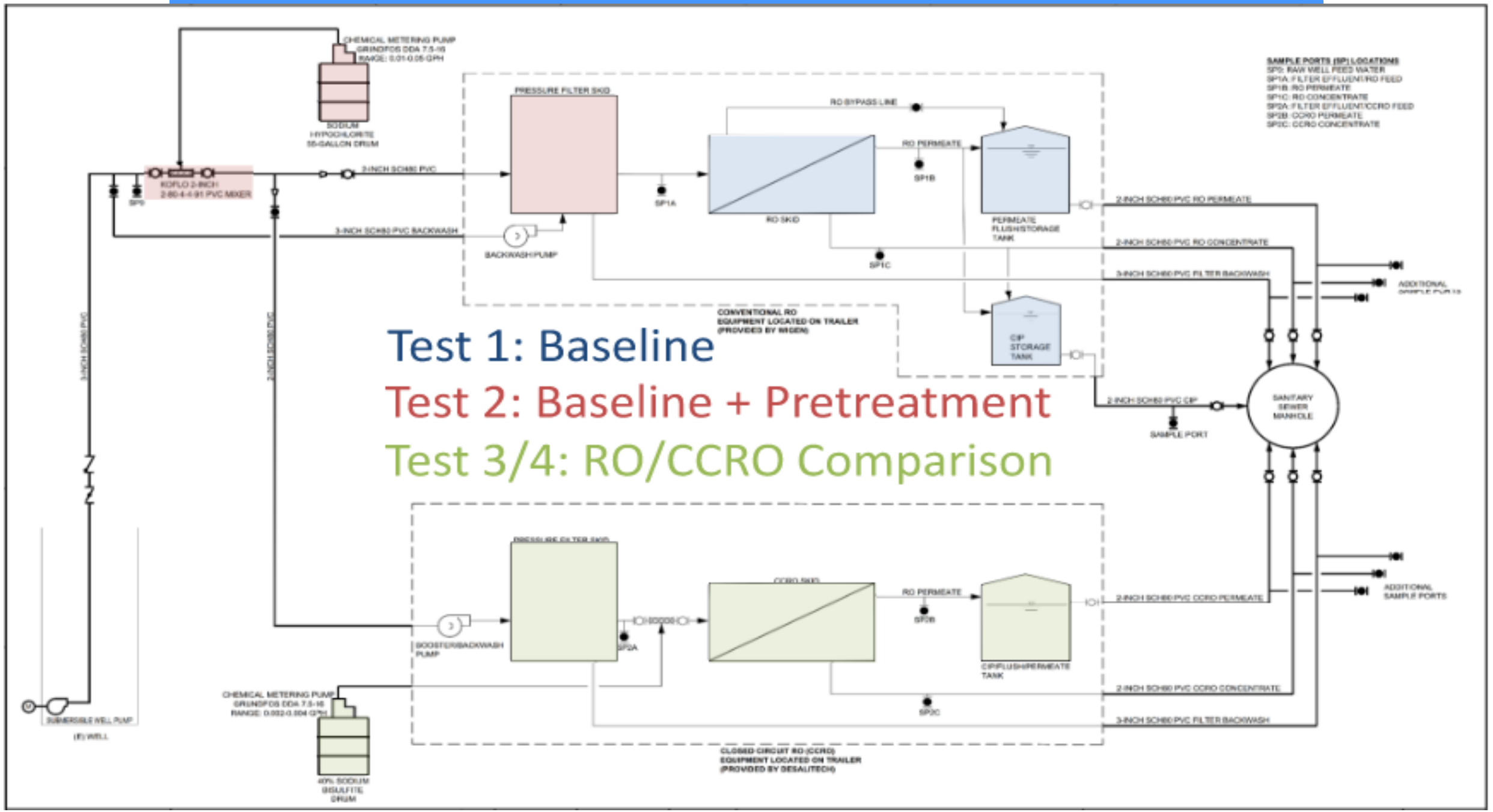


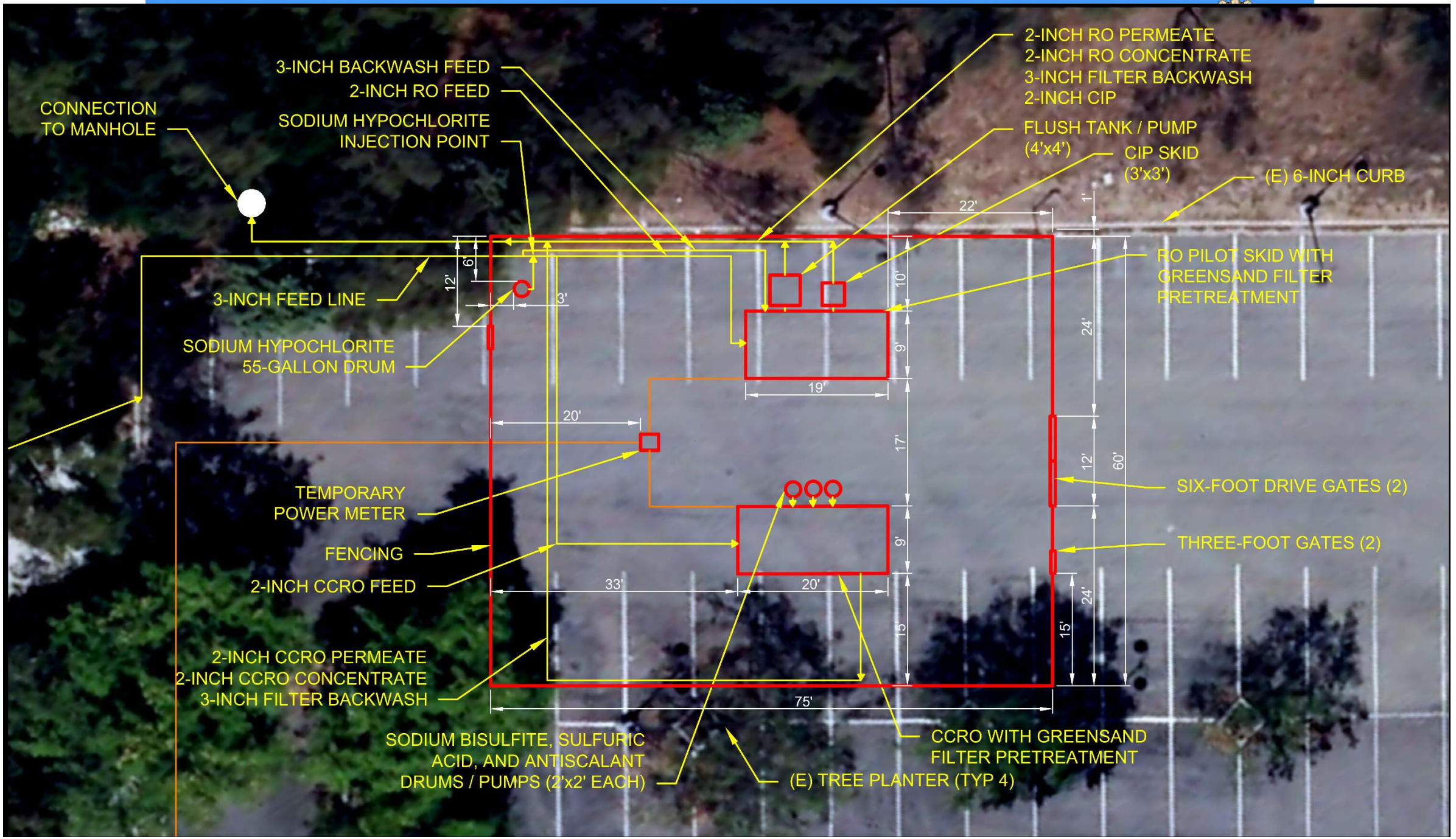
Pilot System Design: CCRO

Closed-Circuit Reverse Osmosis (CCRO):

- Semi-batch process.
- Uses standard RO membranes, typically 1-stage array.
- Concentrate normally recirculates to feed side.
- System flushes concentrate through dump valve when target recovery is met.




Test 1: Baseline
Test 2: Baseline + Pretreatment
Test 3/4: RO/CCRO Comparison
CHEMICAL METERING PUMP
GRUNDFOS DDA 7.5-16
RANGE: 0.01-0.05 GPH
SODIUM HYPOCHLORITE 55-GALLON DRUM
KDFLO 2-INCH 2-80-4-4-91 PVC MIXER
SP0
2-INCH SCH80 PVC
3-INCH SCH80 PVC BACKWASH
PRESSURE FILTER SKID
BACKWASH PUMP
SP1A
RO BYPASS LINE
RO SKID
RO PERMEATE
SP1B
SP1C
PERMEATE FLUSH/STORAGE TANK
CIP STORAGE TANK
CONVENTIONAL RO EQUIPMENT LOCATED ON TRAILER (PROVIDED BY WIGEN)
SAMPLE PORTS (SP) LOCATIONS
SP0: RAW WELL FEED WATER
SP1A: FILTER EFFLUENT/RO FEED
SP1B: RO PERMEATE
SP1C: RO CONCENTRATE
SP2A: FILTER EFFLUENT/CCRO FEED
SP2B: CCRO PERMEATE
SP2C: CCRO CONCENTRATE
2-INCH SCH80 PVC RO PERMEATE
2-INCH SCH80 PVC RO CONCENTRATE
3-INCH SCH80 PVC FILTER BACKWASH
ADDITIONAL SAMPLE PORTS
2-INCH SCH80 PVC CIP
SAMPLE PORT
SANITARY SEWER MANHOLE
3-INCH SCH80 PVC
2-INCH SCH80 PVC
SUBMERSIBLE WELL PUMP
(E) WELL
BOOSTER/BACKWASH PUMP
SP2A
CCRO SKID
RO PERMEATE
SP2B
CIP/FLUSH/PERMEATE TANK
SP2C
2-INCH SCH80 PVC CCRO PERMEATE
2-INCH SCH80 PVC CCRO CONCENTRATE
3-INCH SCH80 PVC FILTER BACKWASH
ADDITIONAL SAMPLE PORTS
CHEMICAL METERING PUMP
GRUNDFOS DDA 7.5-16
RANGE: 0.032-0.504 GPH
40% SODIUM BISULFITE DRUM
CLOSED CIRCUIT RO (CCRO) EQUIPMENT LOCATED ON TRAILER (PROVIDED BY DESALITECH)


CONNECTION TO MANHOLE
3-INCH BACKWASH FEED
2-INCH RO FEED
SODIUM HYPOCHLORITE INJECTION POINT
2-INCH RO PERMEATE
2-INCH RO CONCENTRATE
3-INCH FILTER BACKWASH
2-INCH CIP
FLUSH TANK / PUMP (4'x4')
CIP SKID (3'x3')
(E) 6-INCH CURB
RO PILOT SKID WITH GREENSAND FILTER PRETREATMENT
3-INCH FEED LINE
SODIUM HYPOCHLORITE 55-GALLON DRUM
TEMPORARY POWER METER
FENCING
2-INCH CCRO FEED
SIX-FOOT DRIVE GATES (2)
THREE-FOOT GATES (2)
2-INCH CCRO PERMEATE
2-INCH CCRO CONCENTRATE
3-INCH FILTER BACKWASH
SODIUM BISULFITE, SULFURIC ACID, AND ANTISCALANT DRUMS / PUMPS (2'x2' EACH)
CCRO WITH GREENSAND FILTER PRETREATMENT
(E) TREE PLANTER (TYP 4)
22'
1'
6'
12'
3'
10'
9'
19'
24'
20'
17'
12'
60'
9'
33'
20'
15'
24'
15'
75'

Pilot Test Schedule

Test #	Test Description	Approx. Planned Start/End Date	Duration	Actual Start/End Date	Actual Duration	Systems in Operation
Startup	Equipment Delivery, Installation, Startup and Training	2/25/19 3/15/19	3 weeks	2/25/19 3/15/19	3 weeks	
1	Baseline Duration	3/20/19 5/3/19	6 weeks	3/20/19 5/7/19	7 Weeks	RO Only (Pretreatment filter to be bypassed)
2	Pretreatment Comparison	5/6/19 6/14/19	6 weeks	5/10/19 7/19/19	10 Weeks	Filtration + RO
3	Recovery Optimization - 1	6/17/19 7/26/19	6 weeks	7/28/19 9/17/19	7 Weeks	Filtration + RO & Filtration + CCRO
4	Recovery/Flux Optimization - 2	7/29/19 9/6/19	6 weeks	9/20/19 11/1/19	6 Weeks	Filtration + RO & Filtration + CCRO
Shutdown	Equipment Shutdown, Packing, and Shipping	9/9/19 9/13/19	1 week	11/4/19 11/8/19	1 Week	

Pilot Test Learnings Summary

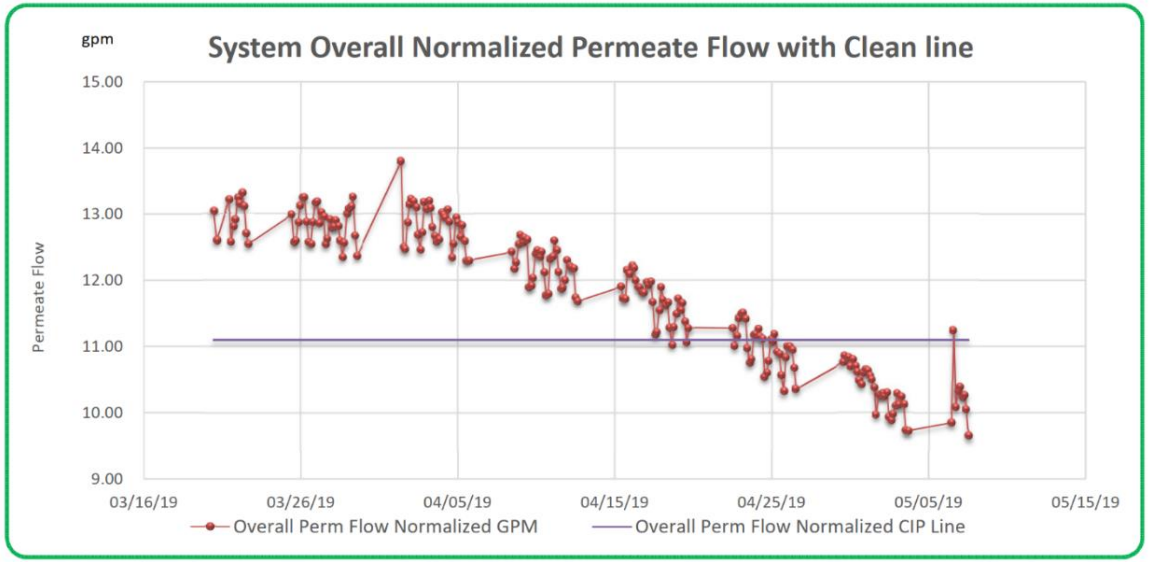
Test	Train/Configuration	Recovery Setpoint	Chemicals	Objective	Duration Until CIP Required (Goal: 3-6 months)	Learnings
Test #1	Conventional RO	79%	Antiscalant Sulfuric Acid	Establish operational baseline without pretreatment.	~1.5 Months Goal not met.	Silica, not calcium carbonate, determined to be limiting scalant.
Test #2	Conventional w/Prefiltration	79%	Sodium Hypochlorite Antiscalant Sodium Bisulfite	Compare impact of prefiltration to baseline operation.	~1.5 Months. Goal not met.	RO system cannot meet recovery setpoint of 79%.
Test #3	Conventional RO w/Prefiltration	76%	Sodium Hypochlorite Antiscalant Sodium Bisulfite	Optimize Conventional RO recovery rate by either lowering or increasing recovery rate to meet 3-6-month CIP objective.	~4 – 6 Months (Projection). Goal met.	Confirmed recovery of 76% is achievable. No acid addition required.
	Closed-Circuit RO w/Prefiltration	76%	Sodium Hypochlorite Antiscalant Sodium Bisulfite	Establish minimum recovery for CCRO system.	~1 Month Goal not met.	Iron fouling of CCRO membranes supports need for iron and manganese pretreatment.
Test #4	Conventional RO w/Prefiltration	76%	Sodium Hypochlorite Antiscalant Sodium Bisulfite	Gather additional operational data.	~0.5 Months Goal not met.	Full-scale system shall alarm/shutdown if the feed ORP exceeds a certain threshold for a defined period of time to prevent membrane degredation.
	Closed-Circuit RO w/Prefiltration	76% - 82%	Sodium Hypochlorite Antiscalant Sodium Bisulfite Sulfuric Acid	Maximize system recovery while ensuring CIP goal is achieved.	~ 6 Months (Projection). Goal met.	CCRO system can operate at a recovery of at least 82%. Acid addition required.

Test #1 Results Summary

- Recovery Rate: 79%

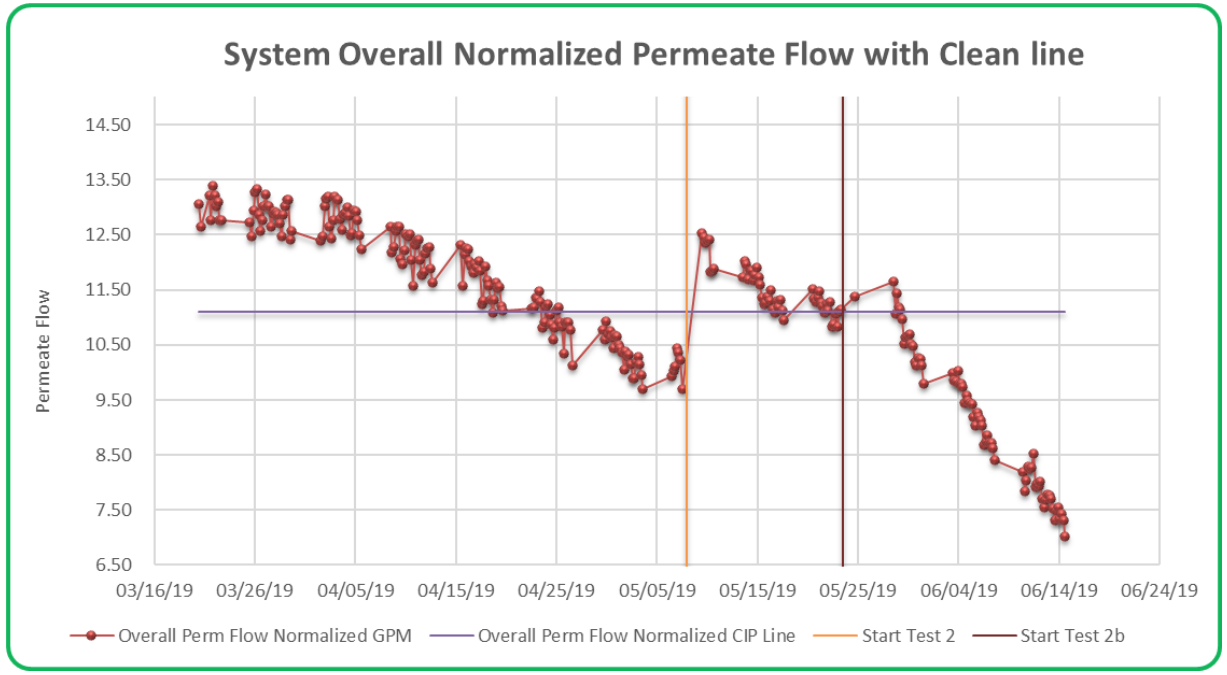
- Test #1 indicated fouling over a short duration – required a Clean-In-Place (CIP) after ~5-6 weeks.

- Removed and autopsied first stage lead element and second stage lag RO membranes.



Test #2 Results Summary

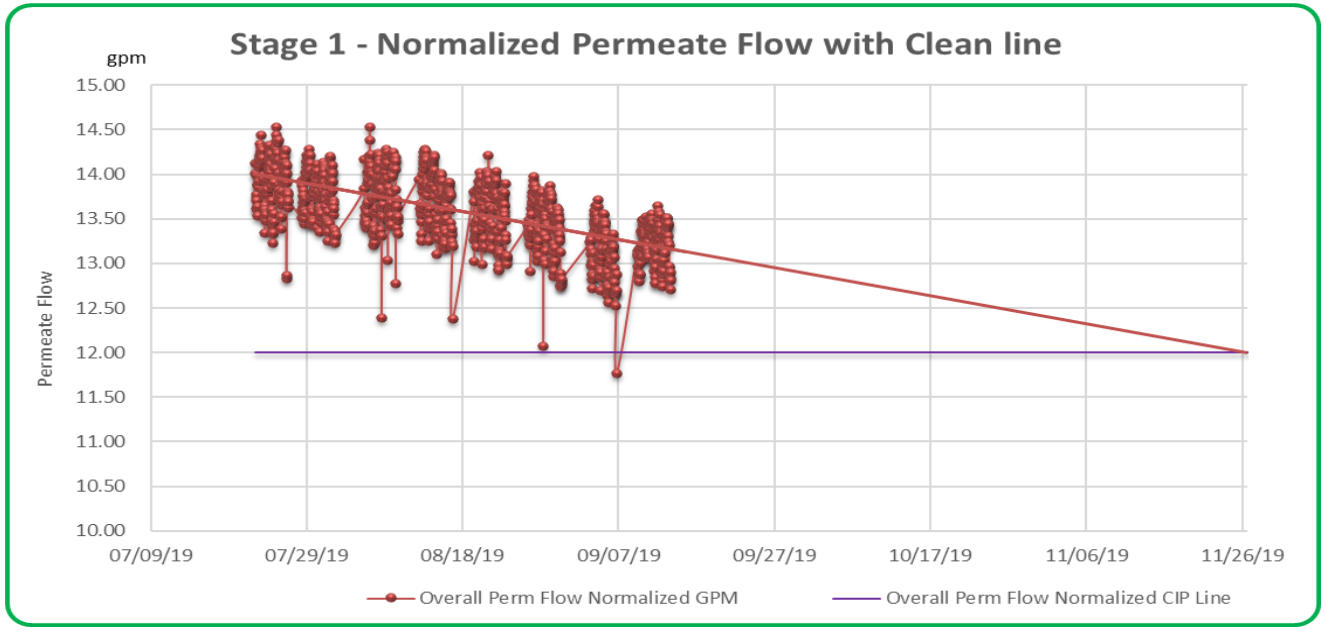
- Review of performance data indicated that recoveries occasionally operated above the setpoint of 79% as a result of the pilot programming/flow balancing protocol.
- Lab data indicated silica concentrations greater than historical data, and that a lower recovery setpoint is required based on silica as the limiting scalant.
- Autopsy results support silica as the limiting scalant and identifies the potential of membrane damage as a result of significant silica buildup in lag elements.



Test #3 Results Summary

Conventional RO

- Reducing recovery to 76% as a result of the higher silica concentrations was successful
- Achieved CIP goal with a projected runtime of six months.

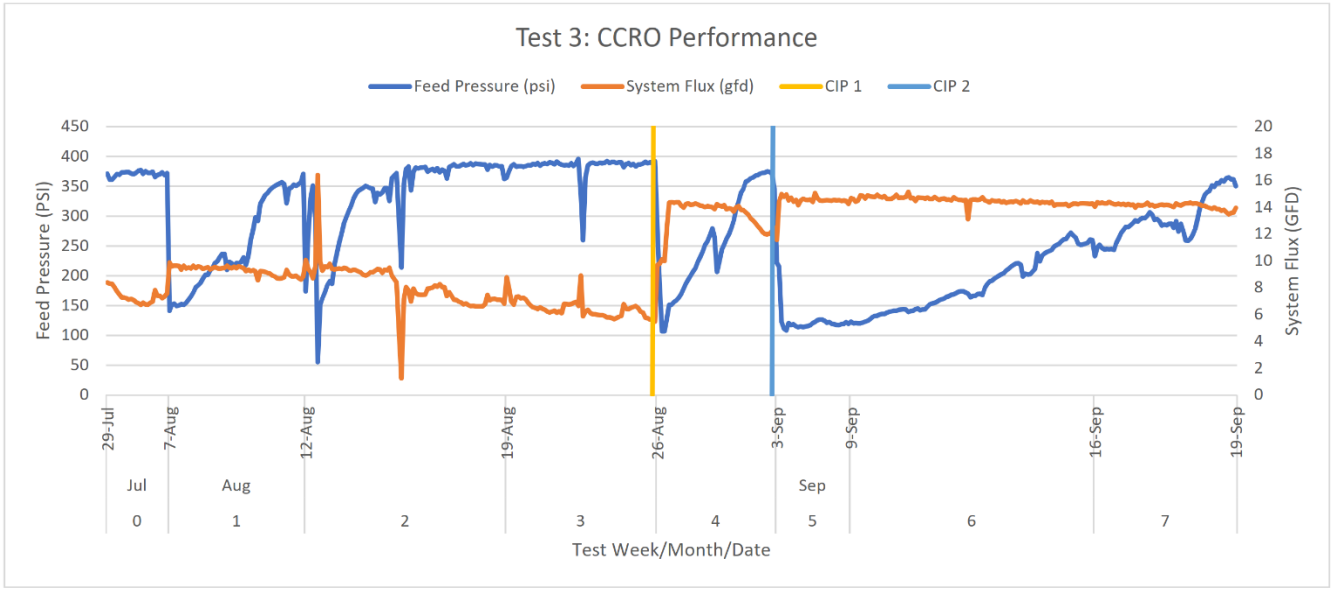


Test #3 Results Summary

CCRO

- Oxidized iron bypassed the filter and quickly fouled the membranes, requiring a CIP to be performed

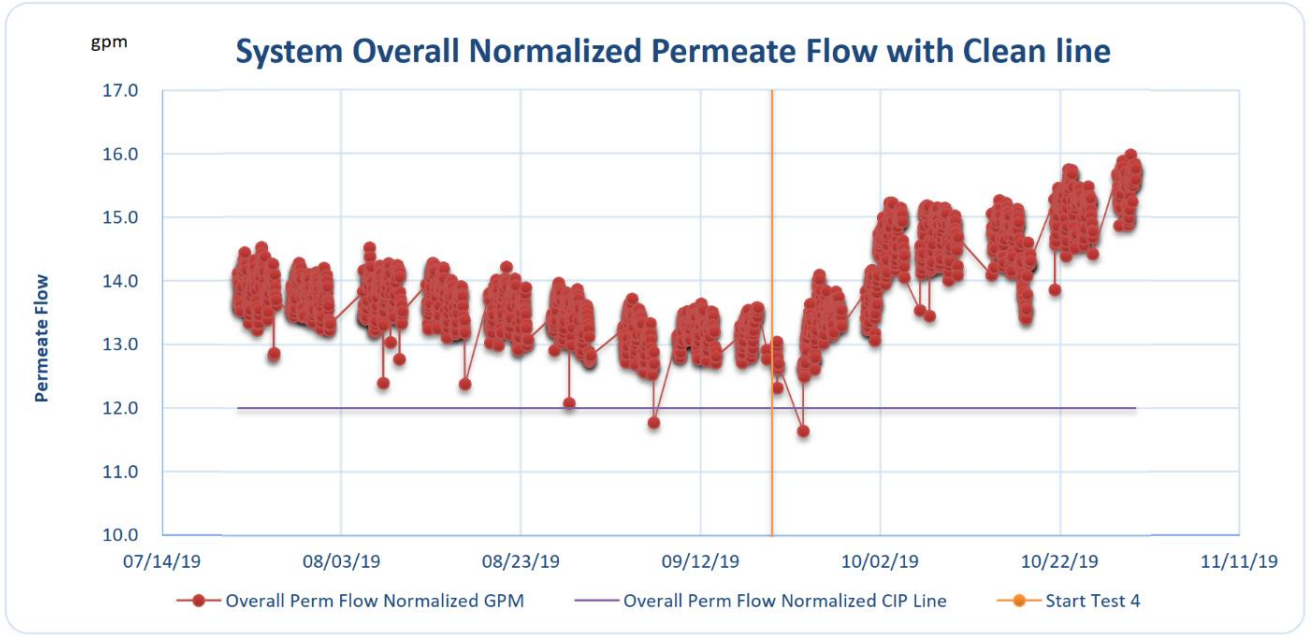
- In a full-scale system with no iron pretreatment, if the feed water was exposed to oxygen, such as in the RO/CCRO feed tank, a similar fouling of the membranes by iron would occur



Test #4 Results Summary

Conventional RO

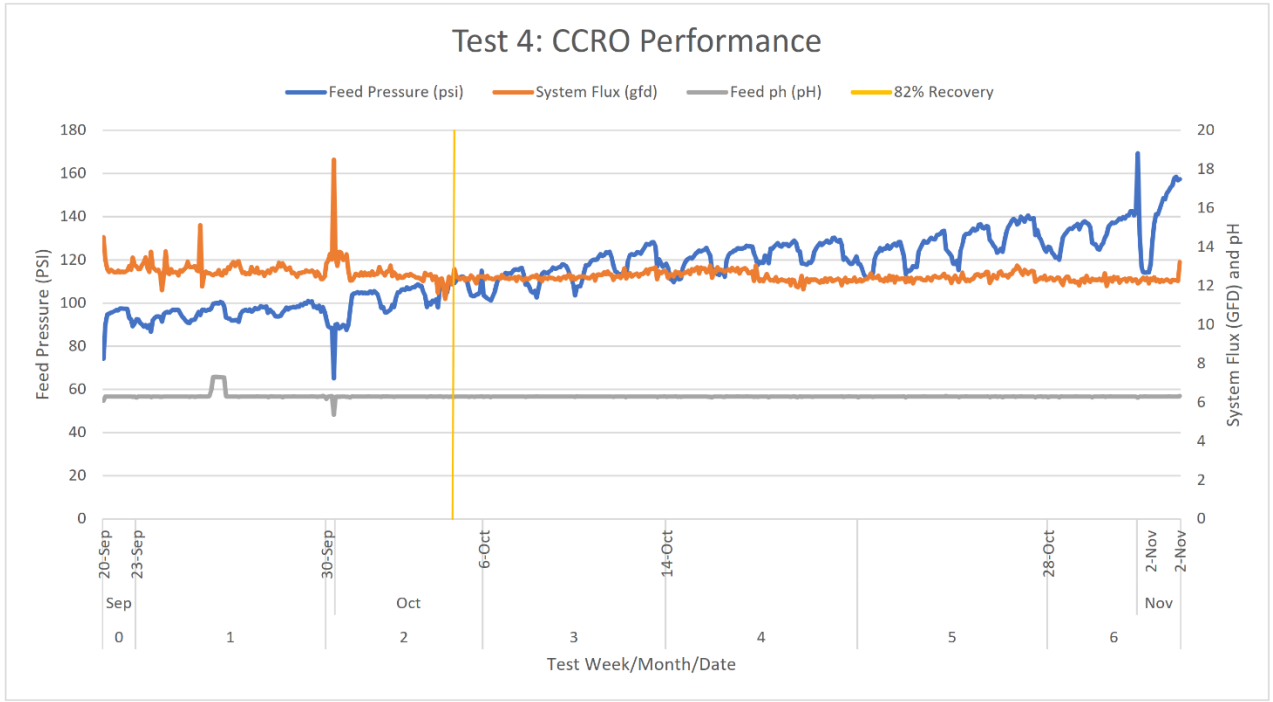
- Data indicates membranes may have been damaged by sodium hypochlorite Salt passage exceeded requirements
- Recommended that full-scale system alarm/shutdown if the feed ORP exceeds a certain threshold for a defined period of time



Test #4 Results Summary

CCRO

- Met its runtime goal with a projected runtime of six months.
- Confirms that the CCRO system can operate at a recovery of at least 82%.
- Acid addition will be required.



Pilot Test Findings

- Refined raw Water quality
- Confirmed pretreatment requirement
- Design constraints for pretreatment (iron)
- Optimized recovery for both treatment trains
- Refined bypass blend ratio

Regional Applicability

- High TDS is a prevalent issue in CVGB
- Optimizing treatment recovery to maximize use of groundwater supply
- The pilot study suggests that the CCRO technology could be an alternative to the use of Conventional RO for groundwater treatment
- Addressing Iron pretreatment to optimize RO operations

Questions & Discussion