Understanding Your Options for Brine Management:

Treatment Technologies and Application in Design

WateReuse Los Angeles

Chapter Meeting
9 October 2018

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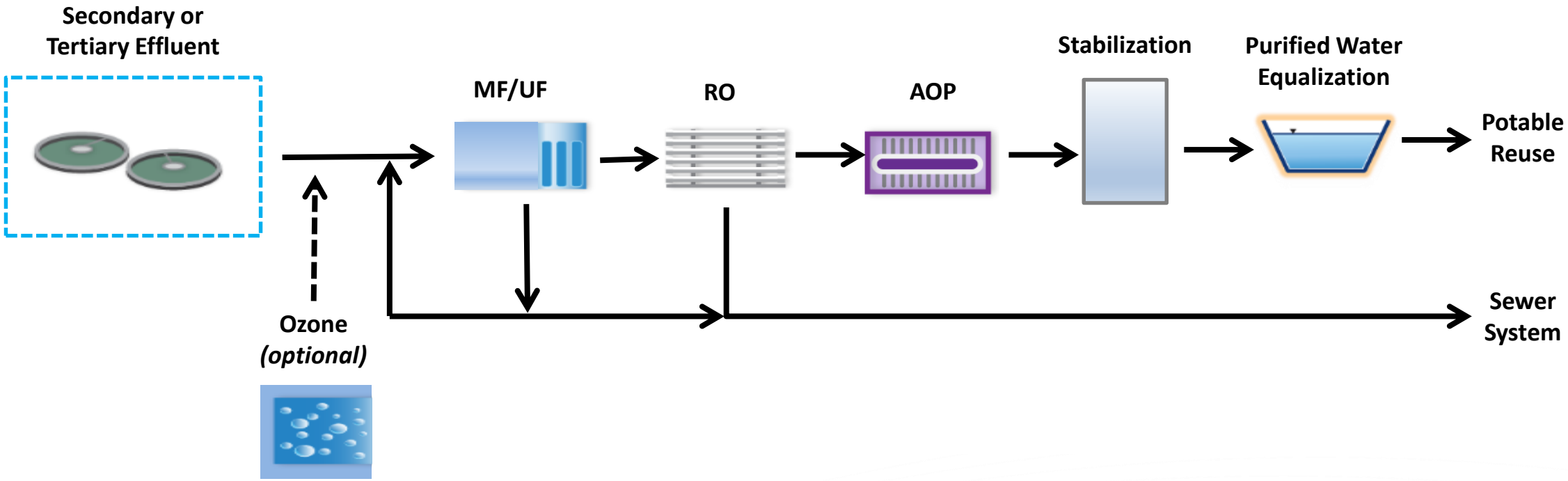
Overview of Today's Presentation

1. Reasons for Managing Brine
2. Advanced Water Treatment Train
3. Brine Treatment Technologies
    1. Recovery Rates
    2. Pros/Cons
    3. Example Facilities
4. Evaluation of Brine Minimization Technologies
    1. Non-Cost Factors
    2. Cost Factors
5. Take-Aways

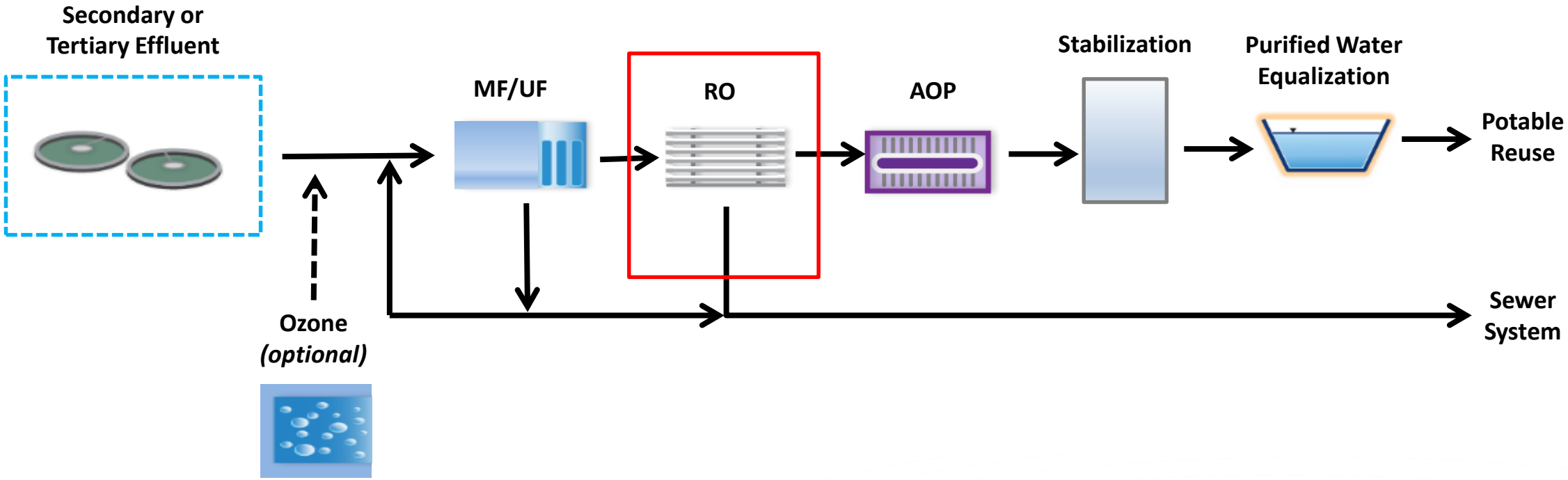
Reasons for Managing Brine

- Maximize existing water supply
  - As population increases, water quality and availability decreases
  - Do more with less
- Applicable to multiple source waters
  - Wastewater effluent
  - Ground water
  - Brackish water
  - Ocean desalination

Advanced Water Treatment Train



Advanced Water Treatment Train



Brine Minimization Technologies

1. Two–Stage Reverse Osmosis (No Minimization)
2. Multi-Stage Concentrator
3. Closed Circuit Reverse Osmosis
4. Electrodialysis Reversal

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- Forward Osmosis
- High-Efficiency Reverse Osmosis (HERO)
- Capacitive Deionization
- Vibratory Shear-Enhanced Processing

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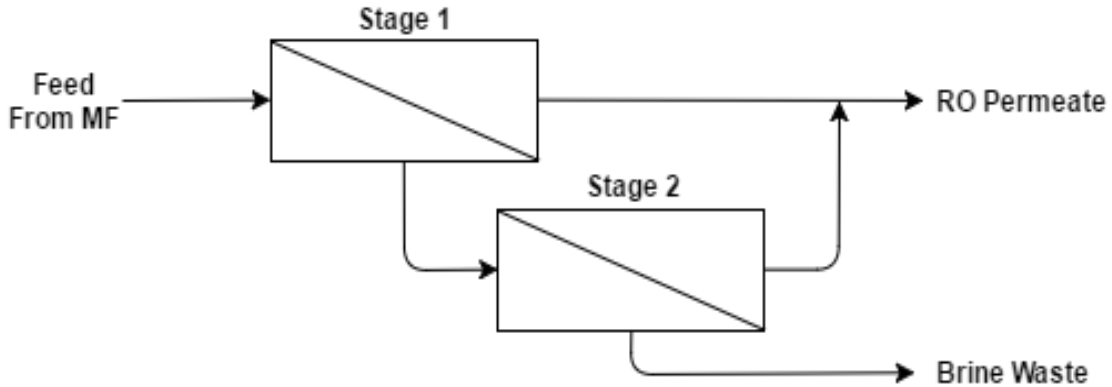
- Zero Liquid Discharge
  - Evaporation Ponds
  - Solar Ponds
  - Crystallizers
  - Spray Dryers
  - Wind-Aided Intensified Evaporation
  - Salt Recovery
  - SAL-PROC
  - Dewvaporation

Two-Stage Reverse Osmosis (No Minimization)

- Recovery: 75-80%
  - 50% each stage
- Pros
  - Low capital cost
  - Low energy usage
  - “Dilute” RO concentrate
- Cons
  - Disposal of large volume of RO concentrate required
  - Low recovery rate



Example Facility for Two-Stage RO: Pure Water Monterey

- 5 MGD Facility (in construction)
  - Feed: 4.94 MGD
  - Permeate: 4.0 MGD (81%)
  - Brine: 0.94 MGD
- **Brine to be mixed with WWTP effluent outfall**

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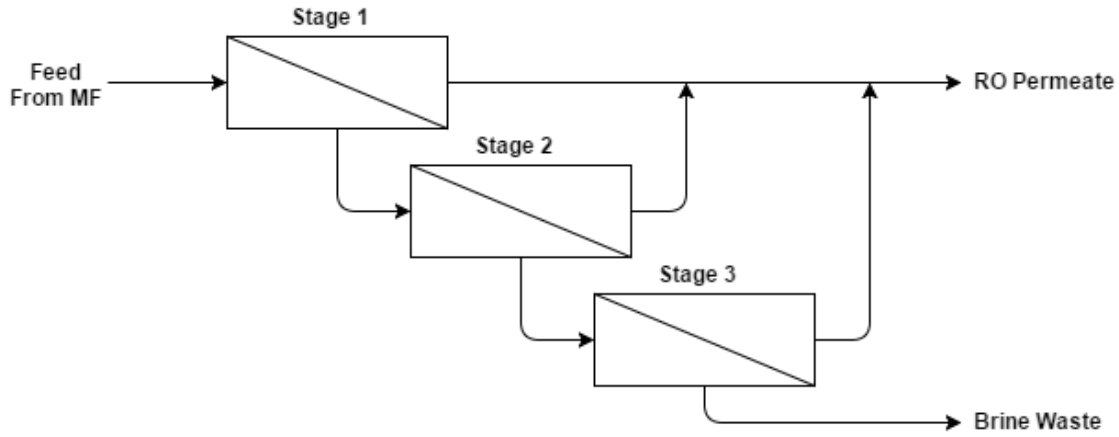
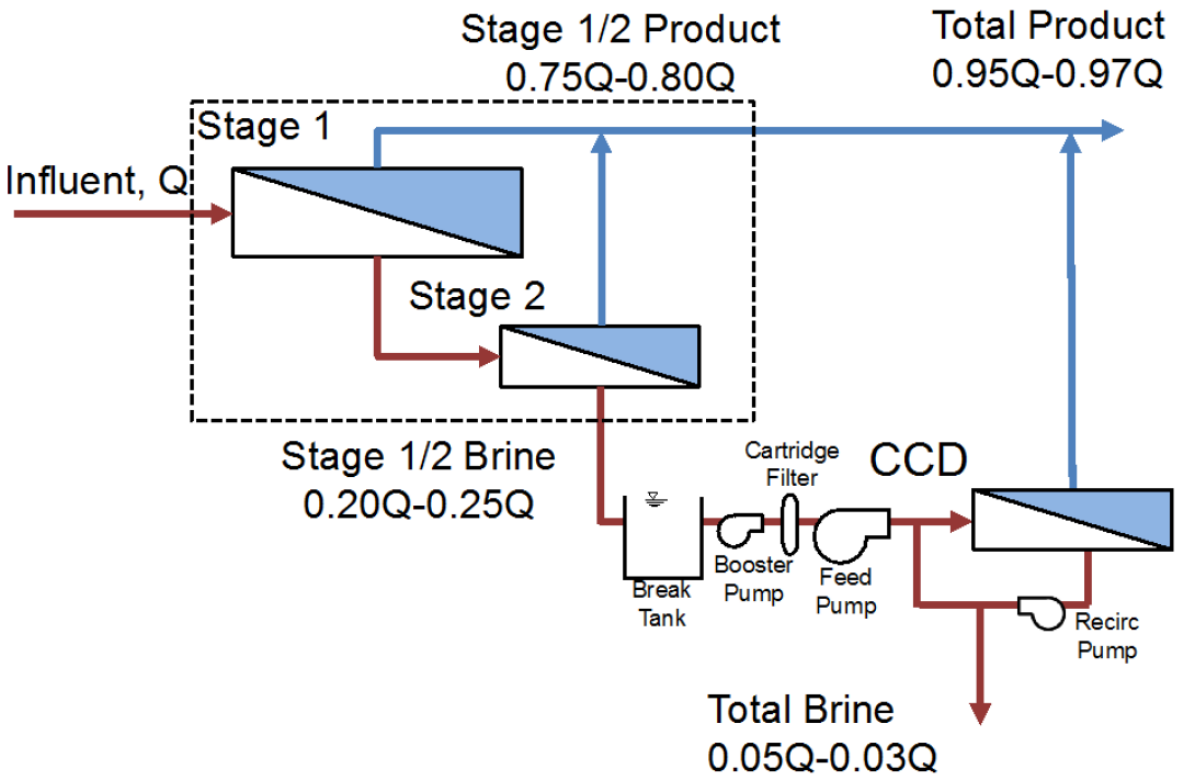
Multi-stage Concentrator

- Recovery: 85-90%
  - 50% each stage
- Pros
  - Medium capital cost
  - Increased recovery/reduced brine
  - Familiar technology
- Cons
  - Increased energy usage
  - Requires careful operation to protect 3rd stage RO



Closed Circuit Reverse Osmosis

- Recovery: 75-95%
  - 50% first two stages
  - 50% to 88% at CCRO
- Pros
  - Flexible recovery rate
  - Lower energy consumption
  - Reduced antiscalant usage
- Cons
  - Proprietary technology
  - Increased capital cost

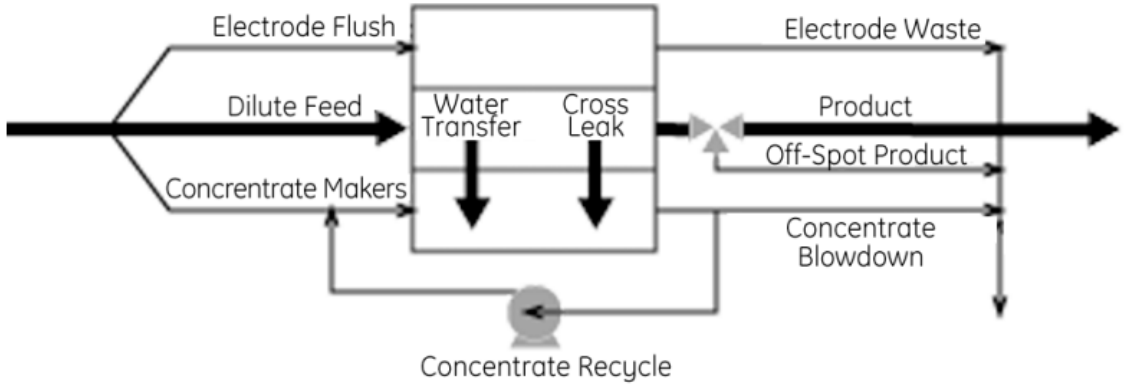


Example Facility for CCRO: Padre Dam Pilot

- Planned 12 MGD facility
  - Extra 1 MGD from secondary RO discharged to Santee Lakes
- **RO waste to be blended with MF waste and sent to sewer system**

Electrodialysis Reversal

- Typical recovery: 70-90%
- Pros
  - High recovery rate
  - Reduced particulate fouling
- Cons
  - Only removes cations/anions
  - Does not provide a “physical barrier”
    - ✓ Permeate must return to head of plant



High-level Comparison of Brine Minimization Technologies

Technology	2-Stage RO (Baseline – No Brine Minimization)	Multi-Stage Concentrator	CCRO	Electrodialysis Reversal
Brine Reduction/Recovery (range)	75 - 80%	85 - 90%	75 - 95%	70 - 90%
Experience, Installations, and Permitting	High	High	Medium	High
Ease of O&M & Flexibility	Medium	Medium	High	Medium
Water Quality	High	High	High	Medium
Footprint and Constructability	High	High	Medium	Low
Non-Cost Ranking	**1**	**1**	**2**	**3**

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Example Life Cycle Costs and Cost Ranking
7.4 MGD Facility with Brine Line

Technology	2-Stage RO (Baseline – No Brine Minimization)	Multi-Stage Concentrator	CCRO	EDR
RO + Brine Minimization Equipment Capital Cost[1] ($M)	$2.7	$3.4	$3.7	$3.9
Brine Line Diameter (in)	12	8	6	6
Brine Line Capital Cost[2] ($M)	$13.5	$9.8	$7.6	$7.6
Annual O&M Costs[3] ($M)	$0.9	$0.6	$0.4	$0.7
Brine Discharged (AFY)	870	440	180	220
Life Cycle Unit Cost ($/AF)	$790	$490	$360	$470
Cost Ranking	**3**	**2**	**1**	**2**

[1] Includes equipment purchasing only for RO and brine minimization systems.

[2] Capital costs for a 12 mile brine line.

[3] Includes energy, chemicals and replacement costs for RO and brine minimization systems plus annual brine discharge fees.

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Example Life Cycle Costs and Cost Ranking 7.4 MGD Facility with Brine Line)

Technology	2 Stage RO (Baseline)	Multistage Concentrator	CCRO	EDR
Non-Cost Ranking	1	1	2	2
Cost Ranking	3	2	1	2
Overall Ranking	**2**	**1**	**1**	**2**

Key Take-Aways

- Each technology has its own strengths/weaknesses
- Costs are very site dependent
  - Access to brine line or ocean outfall
  - Water needs of the service area
  - Available land for construction
- Numerous emerging/niche technologies

- Never too early to consider brine minimization
  1. Feasibility level: consider non-cost and cost factors
  2. Demo best technologies during drafting of preliminary design report (PDR)
  3. Apply learnings from demonstration plant for design

Thank you.

Questions?

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