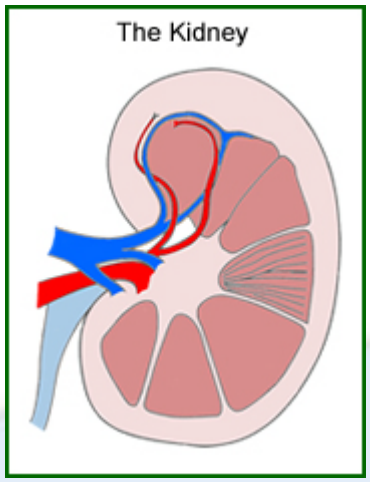

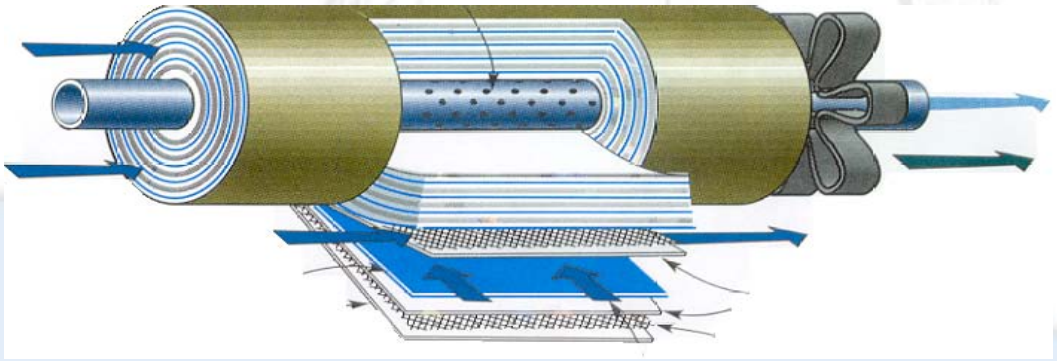

Using Kidneys in Reverse Osmosis

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Thanks to Dr. Tom Davis & Malynda Cappelle of UTEP/CIDS and Bernie Mack & Brad Biagini of Veolia Water Solutions & Technologies

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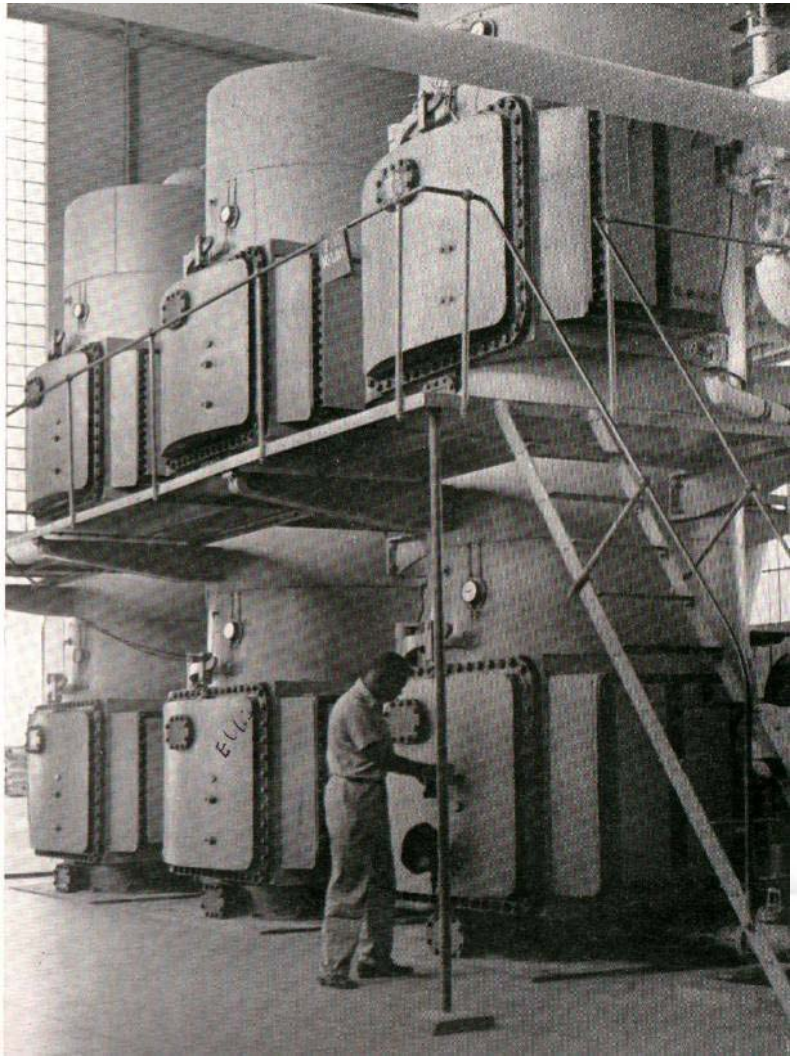
Over 80 Years of Desalting

CaribDA
Caribbean Desalination Association

- CaribDA has over 130 members www.caribda.com
- Some of the first Thermal & Membrane Desal plants
- Conference in the Cayman Islands, June 1 – 4, 2010



Introduction

- More than 1,300 BWRO plants in the US produce about 130 MGD/145,610 AFA (assuming 100,000 gpd/system).
- This number will most likely double within a few years.
- 185 MGD of water is treated, with about 36.4 MGD going to waste (assuming a 70% system recovery).
  This is not sustainable.
- Where does 36.4 MGD/40,770 AFA (810 tons/day of salts) brine go?
  - Sewers, rivers & the ocean
  - Evaporation ponds
  - Deep well injection

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Introduction (cont.)

- Brine Issues:
  - Permits.
  - Increase salinity to other sources.
  - Costs for discharging (energy, land, etc.).
  - Sustainability.
- Where should it go – recover maximum permeate and use resalable salts.
- Lost resource for reuse.
- How do we do it?

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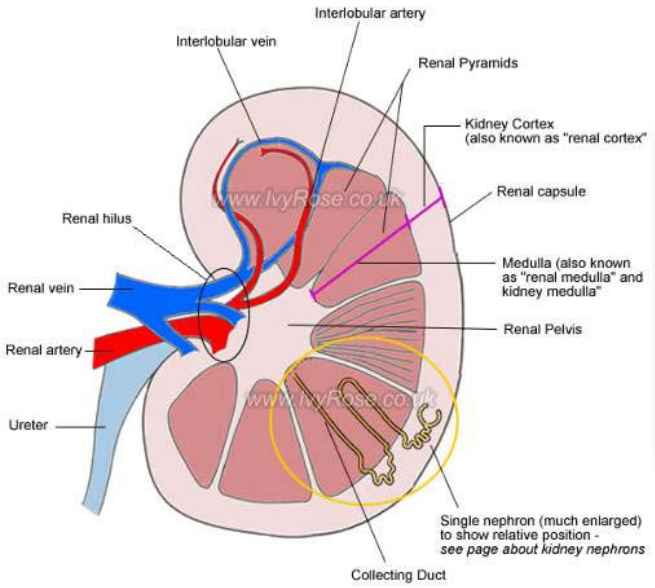
How do we do it? Here's an example

Kidneys in Desalting:

- RO – We all know about RO membranes.
- EDM – Introducing a technology that's been around but keeping a low profile.

Combining Kidneys:

- EDM/ZDD.
- Other bolt-on technologies.



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BWRO – Process Scenarios

- 3-MGD scenarios considered (Alamogordo, NM):
  1. Conventional BWRO.
  2. High recovery BWRO with softening.
  3. ZLD.
  4. ZDD.
- All remaining brine to evaporation ponds.
- ZLD @ 100% (Conventional RO + Evap/Crystallizer) is more than 4½ times the cost to install and operate; therefore, the outcome – ZLD is not considered for this evaluation

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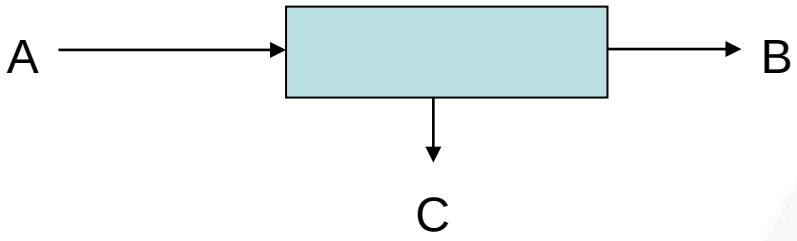
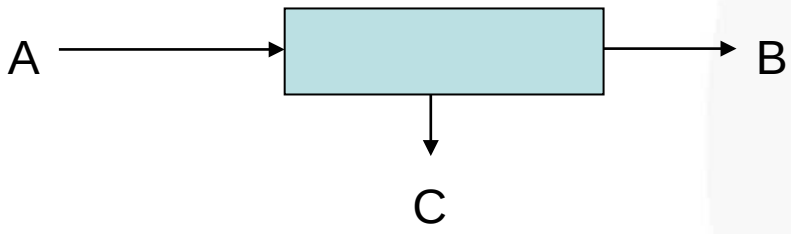
BWRO – Process Scenarios

With Sludge Dewatering System

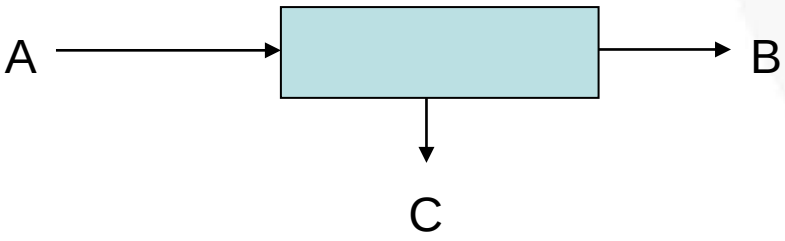
Conventional BWRO @ 72% recovery



Lime Softening & BWRO @ 95% recovery



ZDD @ 97% recovery



	BWRO	HR BWRO	ZDD
A	4.16 MGD	3.15 MGD	3.09 MGD
B	3 MGD	3 MGD	3 MGD
C	1.16 MGD	0.15 MGD	0.09 MGD

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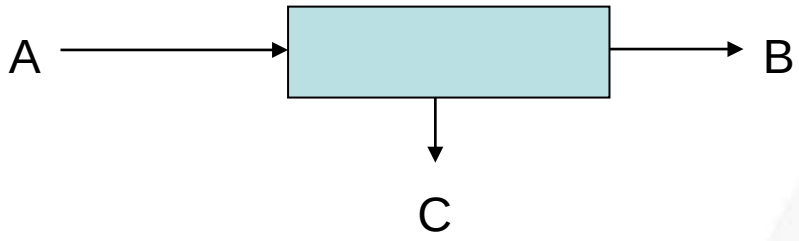
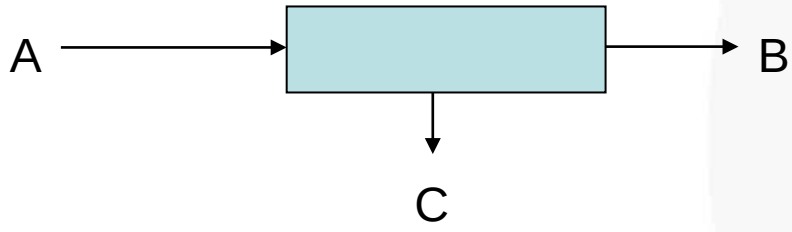
BWRO – Process Scenarios

Without Sludge Dewatering System

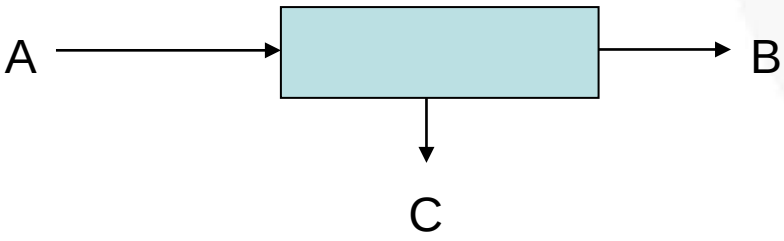
Conventional BWRO @ 72% recovery



Lime Softening & BWRO @ 90% recovery



ZDD @ 94% recovery



	BWRO	HR BWRO	ZDD
A	4.16 MGD	3.33 MGD	3.19 MGD
B	3 MGD	3 MGD	3 MGD
C	1.16 MGD	0.33 MGD	0.19 MGD

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BWRO – Process Scenarios

- Evaporation Pond Sizing (without dewatering):
  - $130,000 / acre lump-sum installation cost.
  - Evaporation rate of 22.8 cm/month (average) per NOAA.
  - Conventional BWRO@72%

    817 gpm concentrate → 147 acres
  - High Recovery BWRO@90%

    231 gpm concentrate → 42 acres
  - ZDD@94%

    150 gpm concentrate → 24 acres

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BWRO – Process Scenarios

- Comparing the three scenarios:
  - ZDD has the lowest installed cost due to the ponds.
  - ZDD has a lower chemical cost than HR BWRO.
  - ZDD'S highest cost is energy consumption. (about twice that of BWRO).

- Outcome:
  - The spreads between the 3 scenarios are within 5-7%.
  - Additional evaluation and piloting of ZDD is ongoing.

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BWRO – Process Scenarios

- Where do we go from here?
  - Compare to deep well injection.
  - Consider alternate energy sources.
  - Continue to look at location-specific saleable products.
  - Develop an interactive LCA tool.
  - Use ZLD as the benchmark?

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