

MULTI-STATE SALINITY COALITION 2008 SALINITY SUMMIT

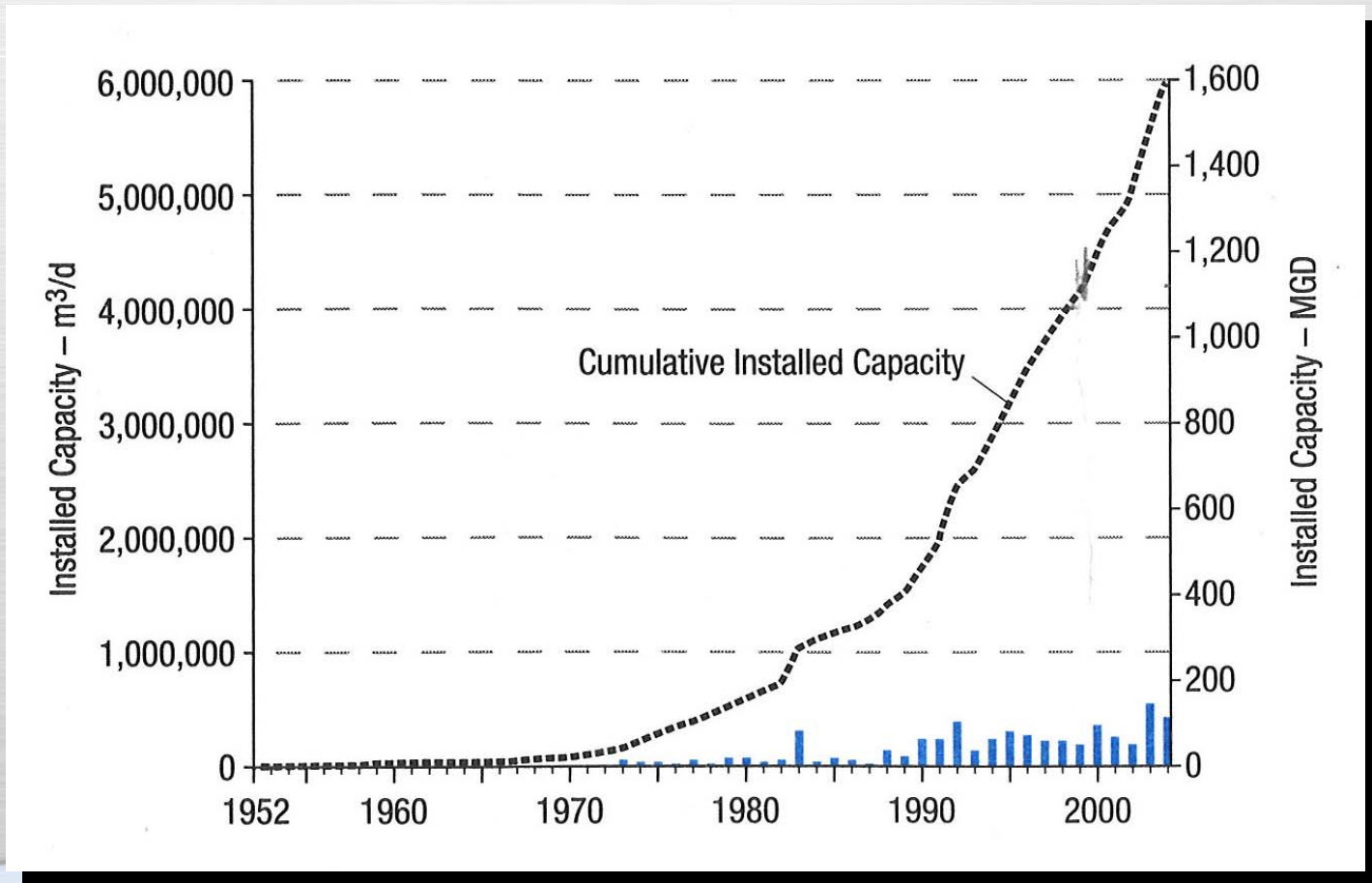
Overview of Concentrate Management Technologies

January 18, 2008

Sandeep Sethi, Ph.D., P.E.

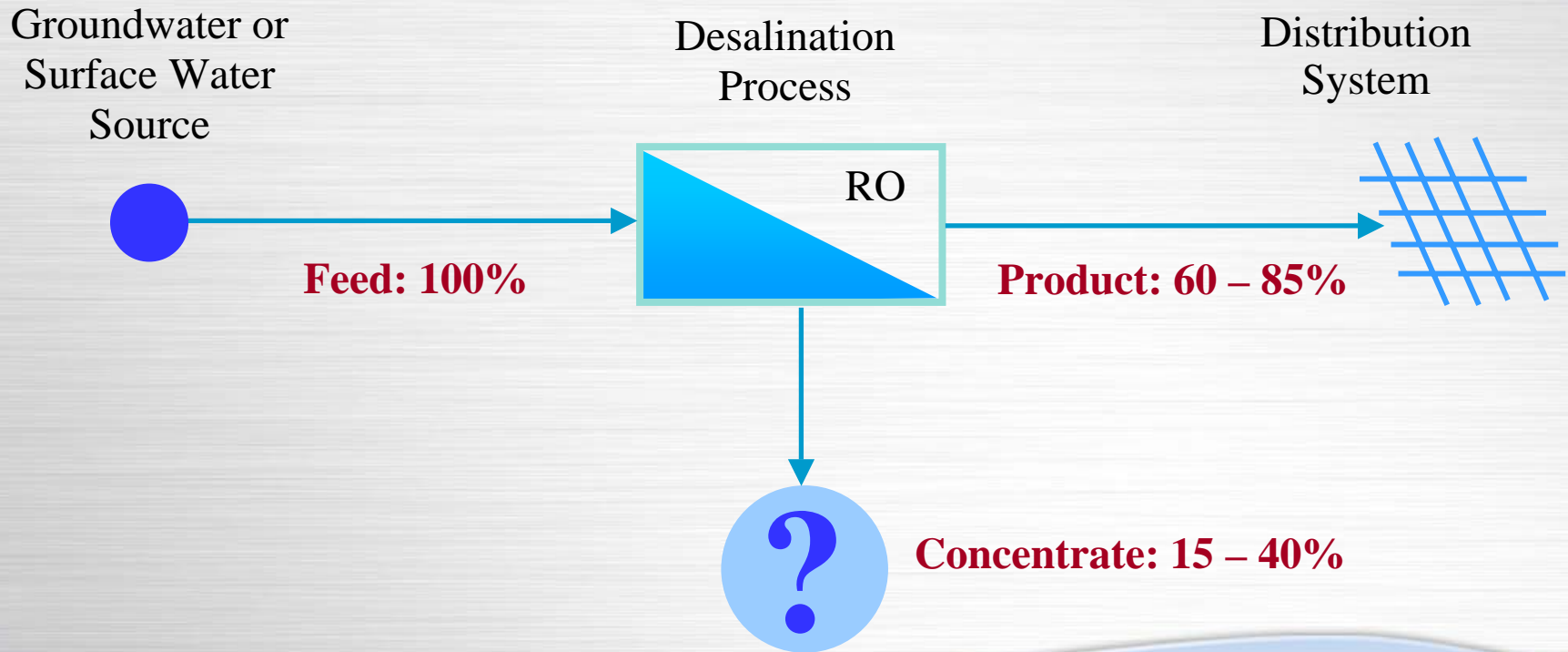


Cumulative U.S. desalting capacity has seen significant growth and doubled in last decade



Source: Cooley et al. (2006) from Wangnick/GWI (2005)

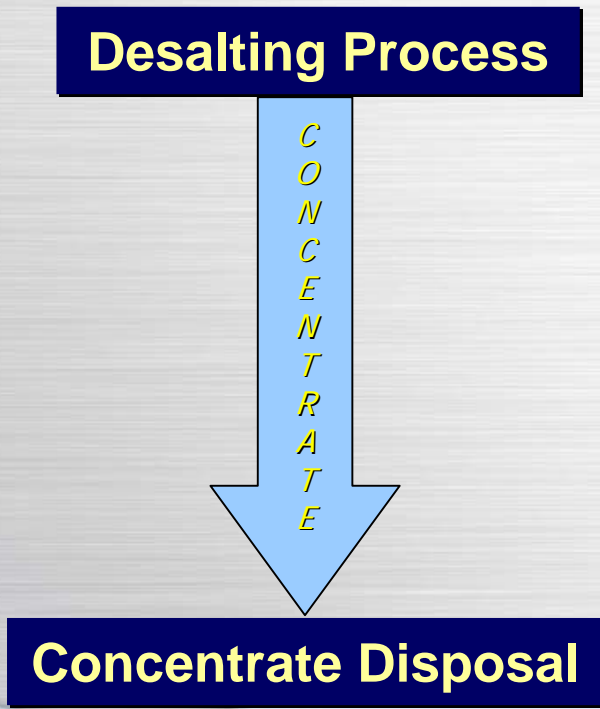
For brackish water desalting applications, recovery is limited due to the solubility limitations of the sparingly soluble salts



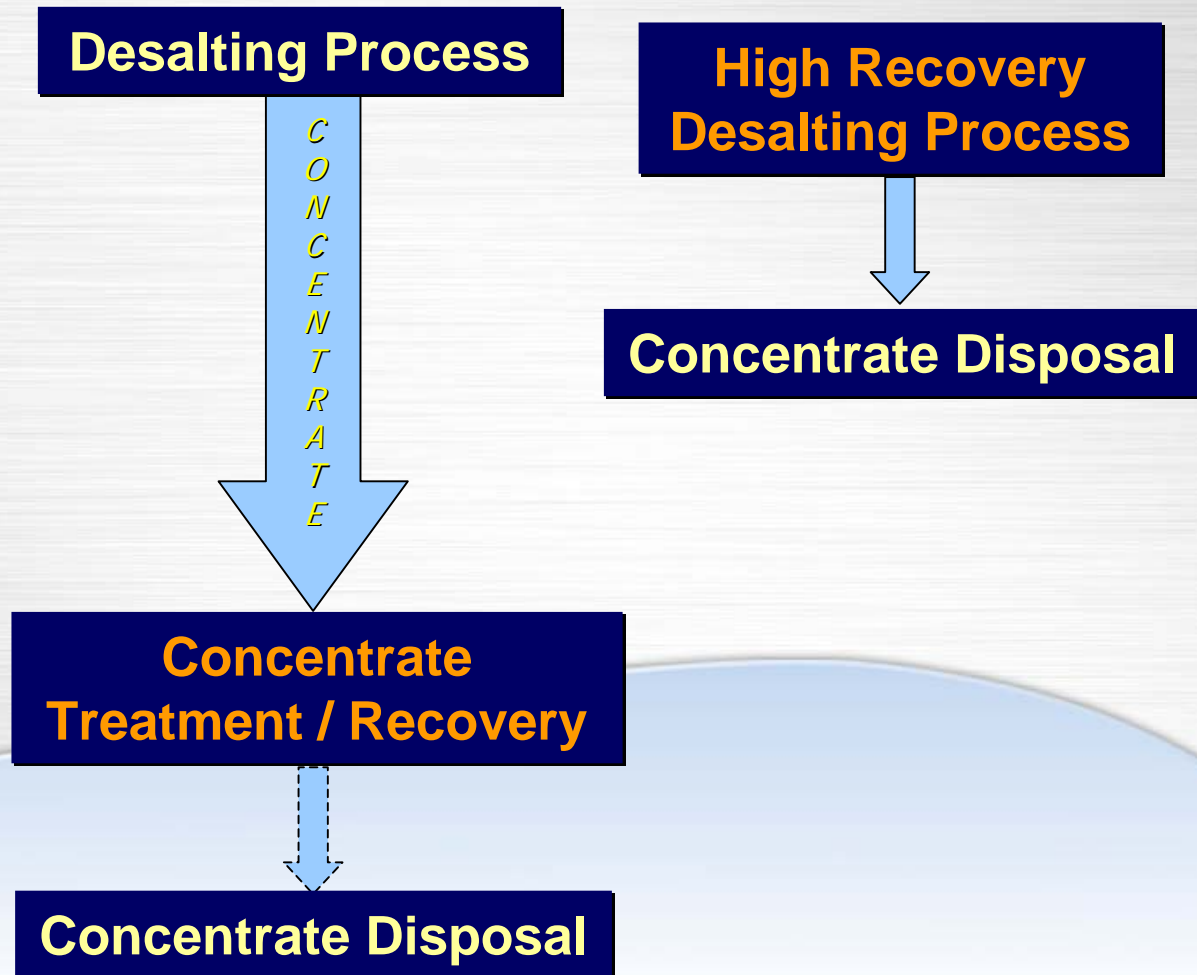
And currently results in 15 - 40% waste stream requiring disposal

Concentrate management (should) include disposal *as well as minimization*

Conventional Paradigm



Developing Paradigms



Several conventional concentrate disposal solutions are available



Surface Water Discharge

Sewer Discharge

Deep Well Injection

Evaporation Pond

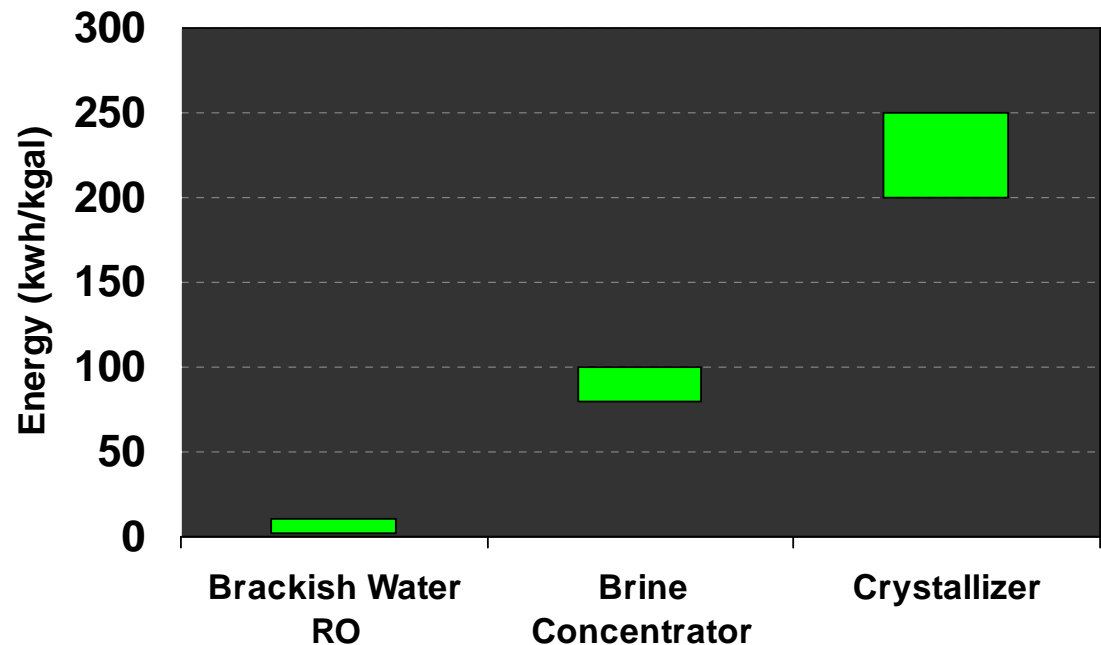
Land Application



But only one conventional option is available for concentrate minimization



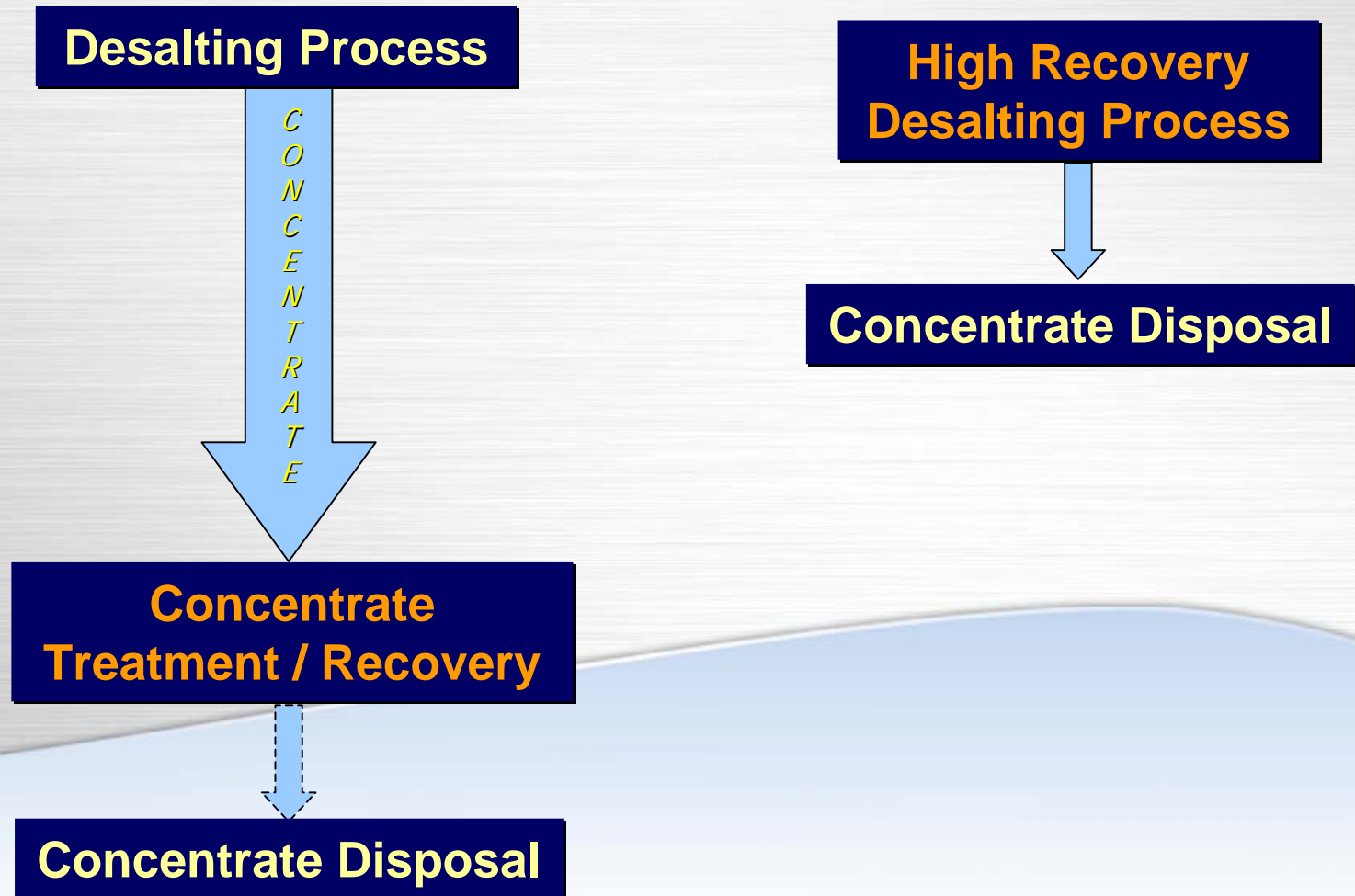
Thermal Concentration (e.g. brine concentrator and crystallizer)



However, it is capital and energy intensive.

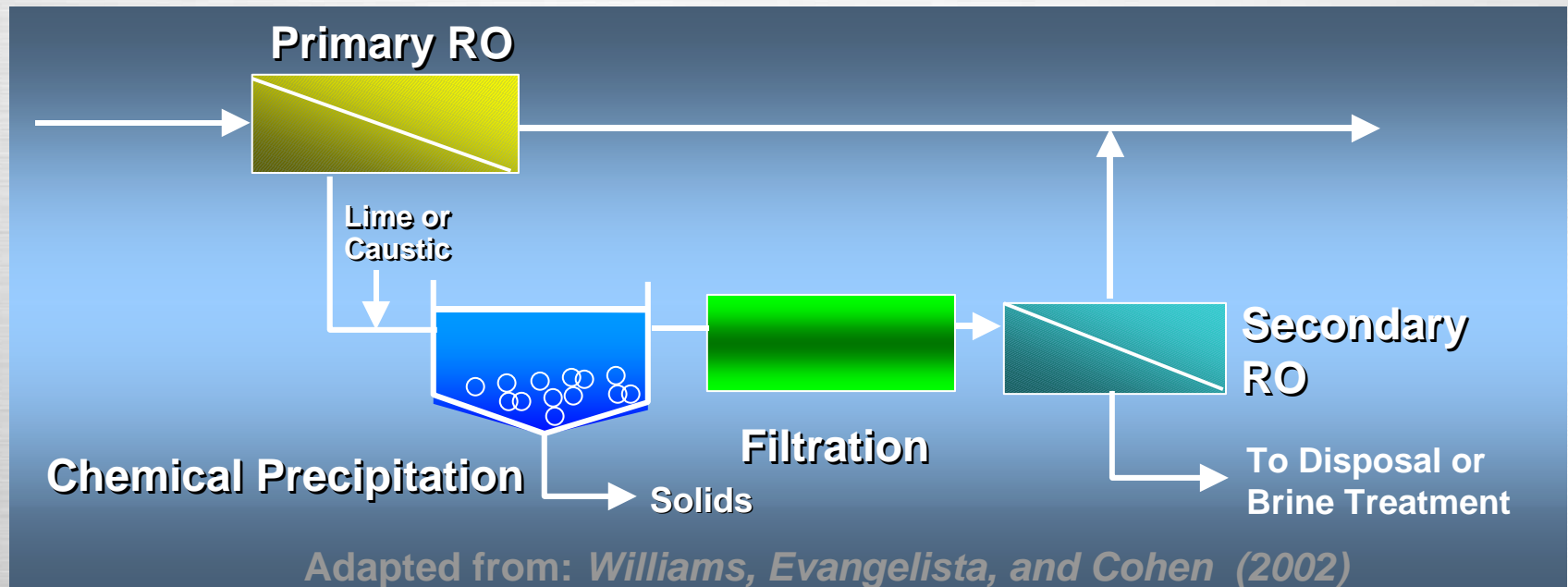
Regulatory pressure and increasing plant sizes are driving the need for better concentrate management

Developing Paradigms



Concentrate treatment and recovery can reduce concentrate to be disposed by 50%

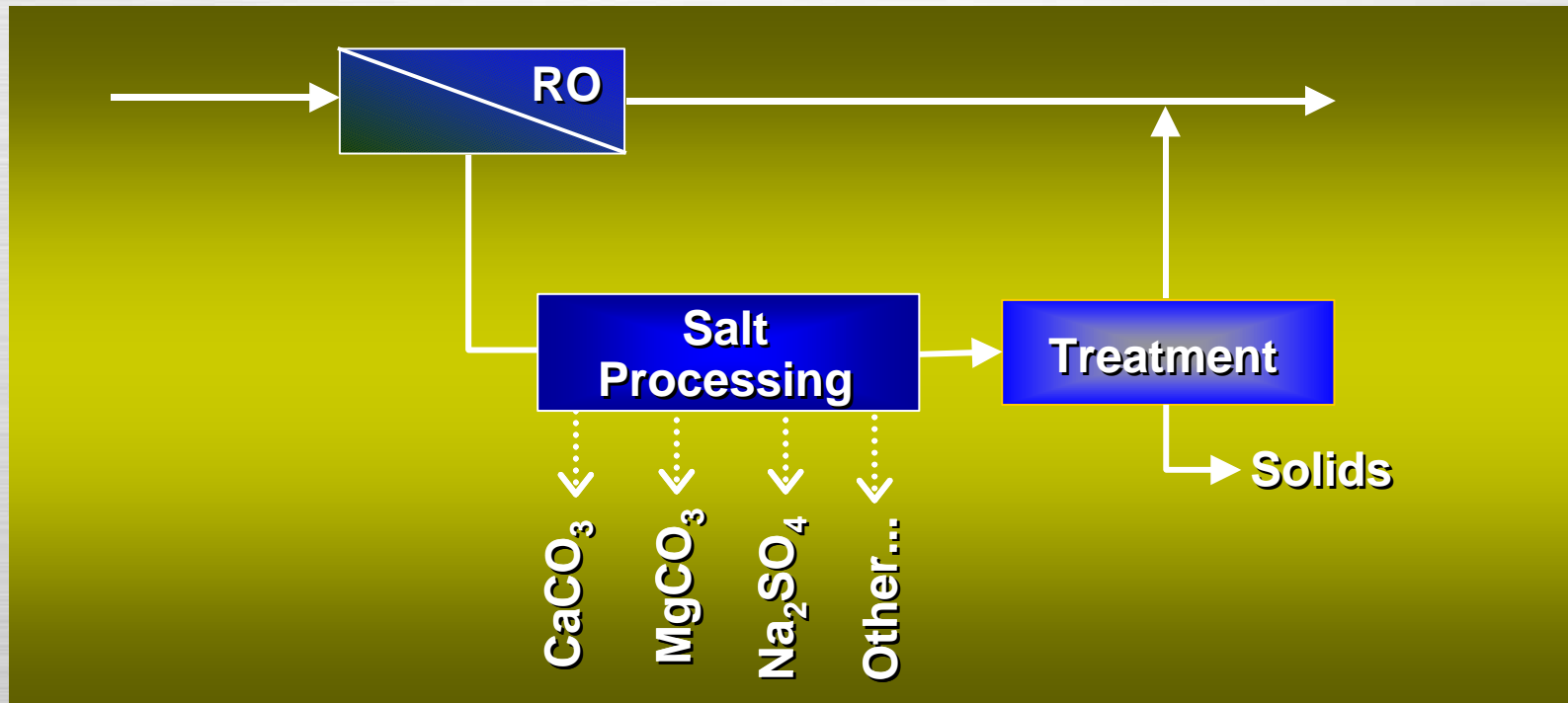
Dual Membrane System Processes with Intermediate Treatment of Concentrate



Other examples include: RO/EDR with Intermediate Chemical Treatment, High Recovery RO (HERO™), Vibratory Shear Enhanced Process (VSEP), etc.

Concentrate reuse and recycle provides beneficial use and effectively reduces need for conventional disposal

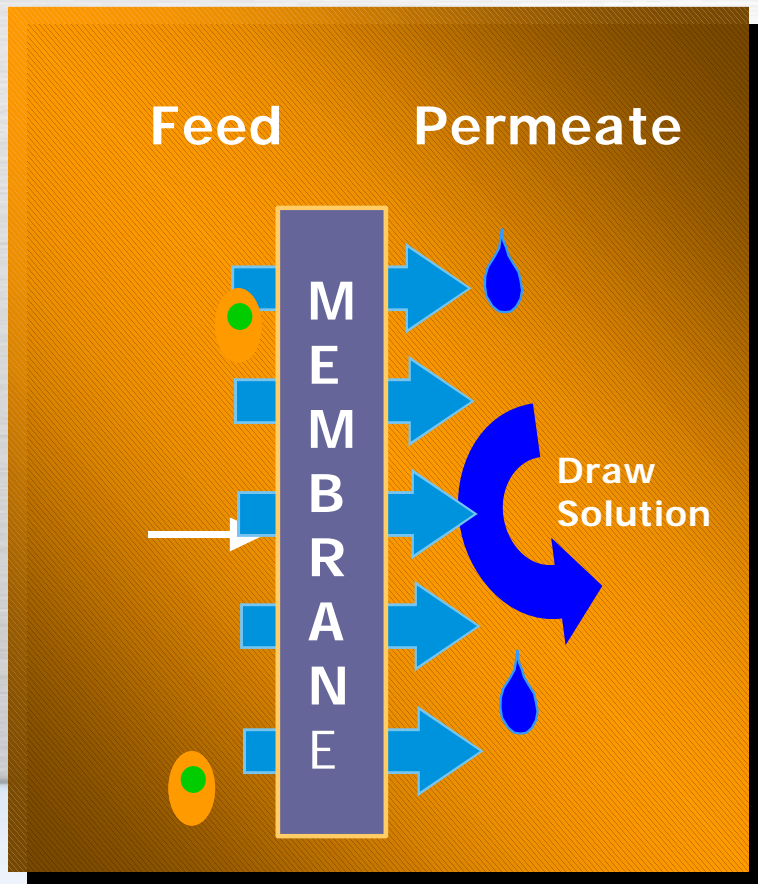
Selective Salt Extraction and Reuse



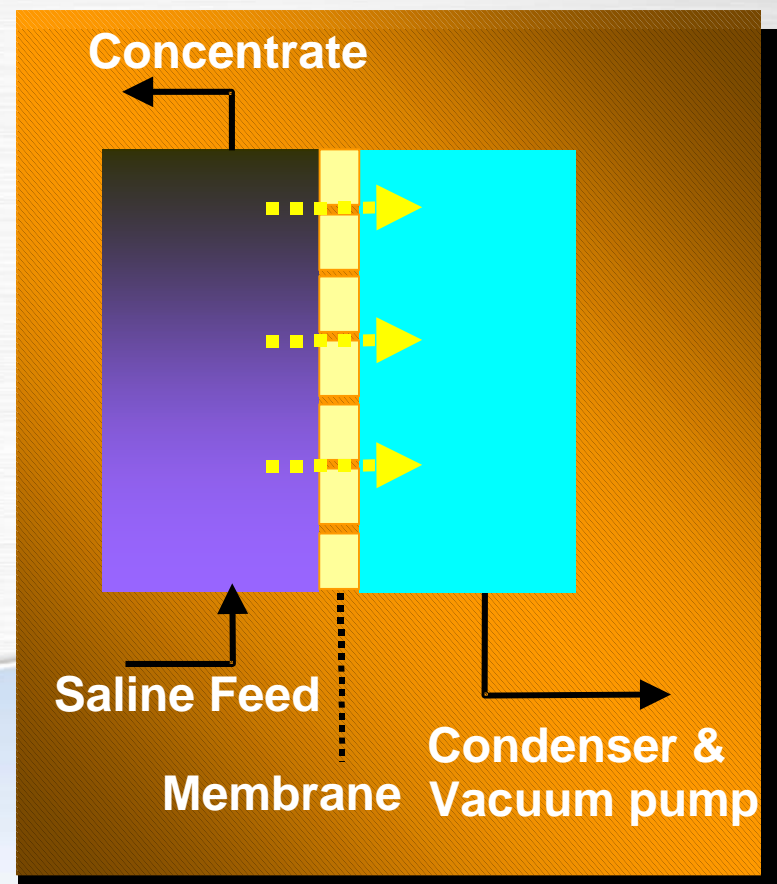
Other examples include: Land Application, Constructed Wetlands, Saltwater Aquariums, etc.

High recovery desalting processes are in various stages of development and generate inherently less concentrate

Forward Osmosis



Membrane Distillation



Summary

- Several conventional concentrate disposal options are available
- Yet each has its own set of limitations: cost, accessibility constraints, permit challenges etc.
- These limitations are becoming more apparent and challenging with stricter regulations.
- Concentrate minimization is becoming an important part of concentrate management
- Thus, concentrate treatment/reuse and high-recovery desalting processes will increasingly become important parts of the concentrate management solution