

Managing Water from CCS Programs

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Questions to be addressed

- Why is water extracted?
- Where are the target formations?
- What is the composition of the extracted water?
- How can the water be managed?
- What do the economics look like?
- What are the major challenges?

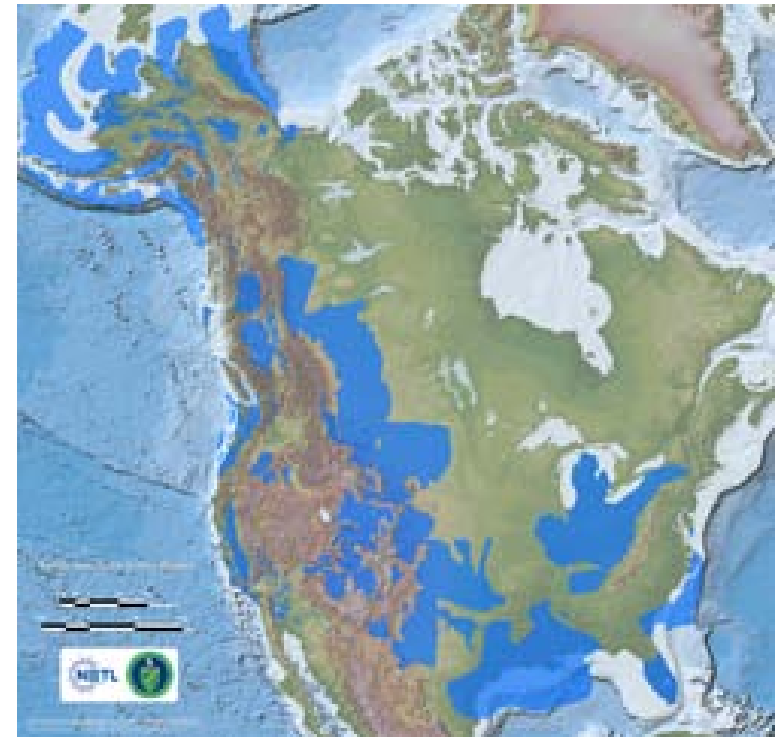


Why Is Water Extracted?

- CCS projects are likely to inject huge volumes of CO₂ into underground formations with suitable properties
- Injection of large volumes of material will create a plume and associated pressure gradient
 - In large-scale projects, the plume could extend laterally for several kilometers
 - This creates more opportunity for the plume to intersect conduits to aquifers and/or the surface
- The size of the plume can be reduced by extracting the water already present in the injection formation
 - Presume that the formations will be deep saline formations

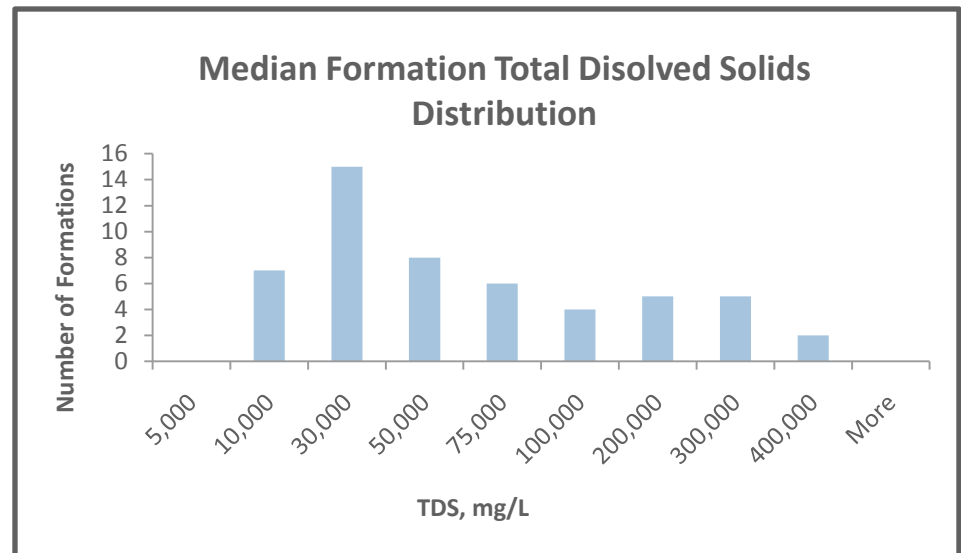
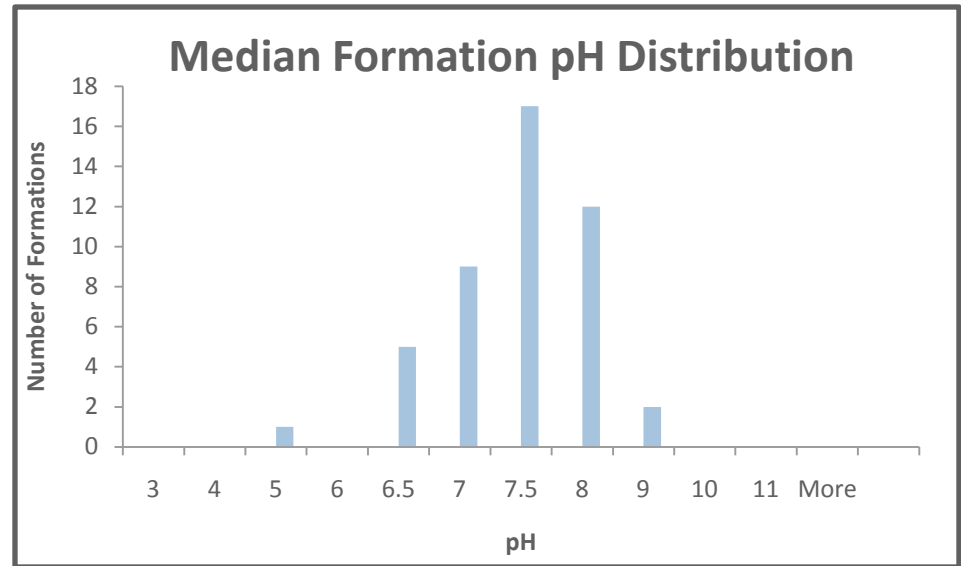
Where are the Target Formations?

- Visited the websites of each regional partnership to identify key target formations
 - Found 86 formations or basins identified as potential future sites for carbon sequestration
 - The total estimated capacity of these saline formations is 3.6 to 14 trillion metric tons
 - Greatest potential in the South East and North West
- Obtained a large database of historical produced water data from NATCARB
 - Found geochemical water quality information for 52 of the 86 locations



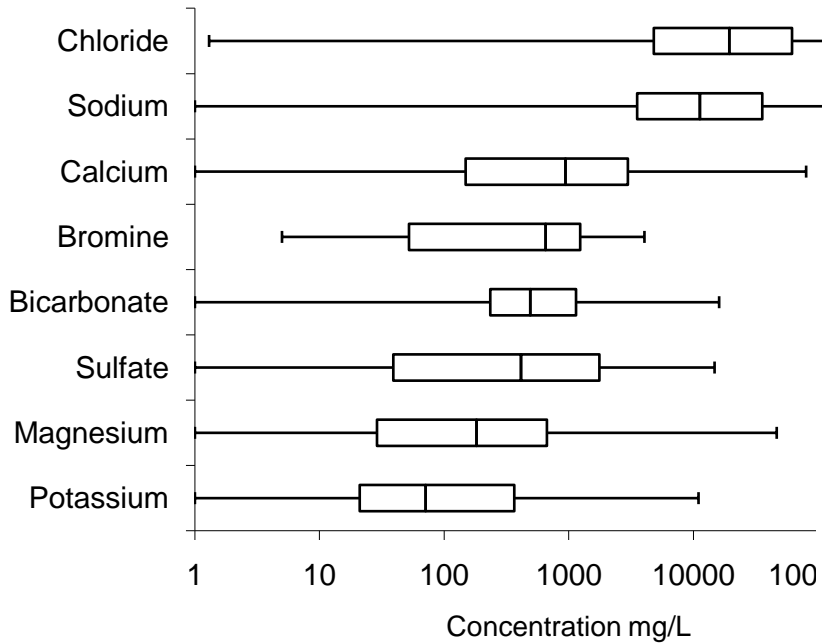
What is the Composition of Formation Water?

- Examples of the geochemical data
 - Formation TDS varies significantly by location
 - Formation pH ranges from slightly acidic to slightly basic
- Management solution must be targeted to unique local brine chemistry

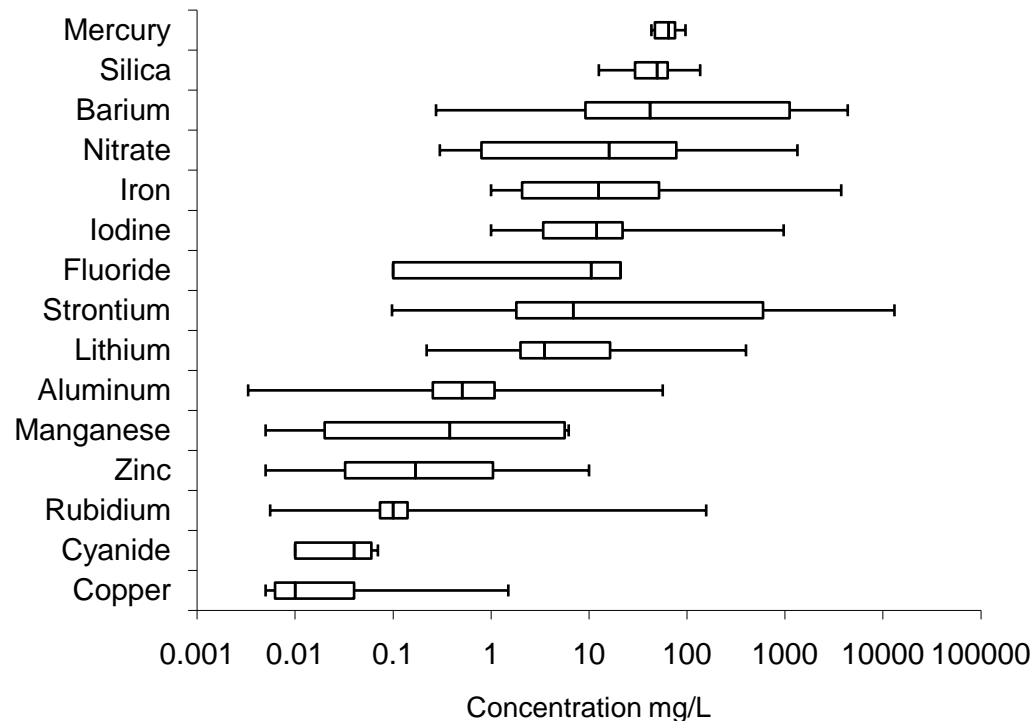


What is the Composition of Saline Formation Water?

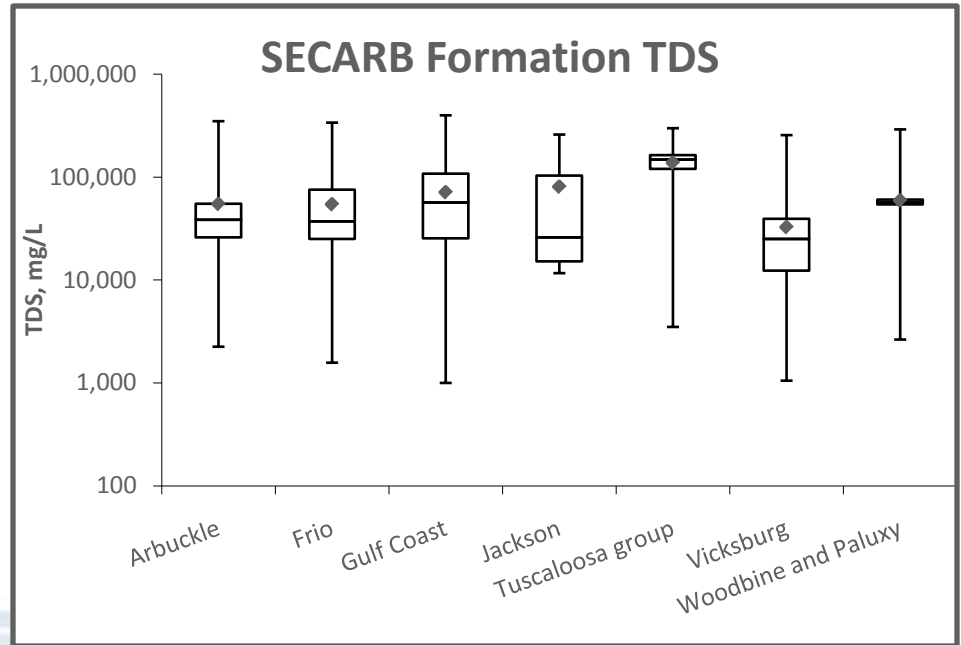
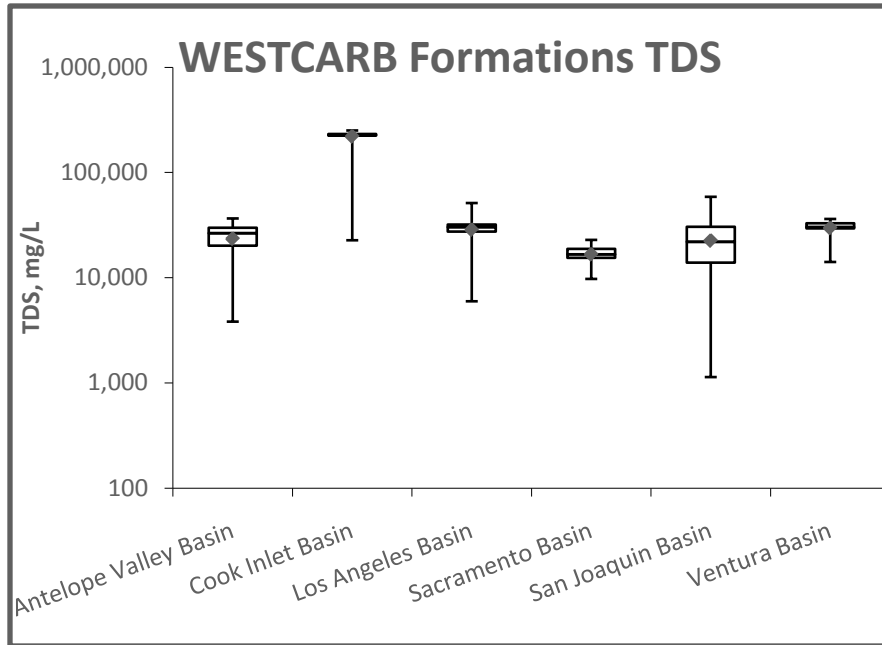
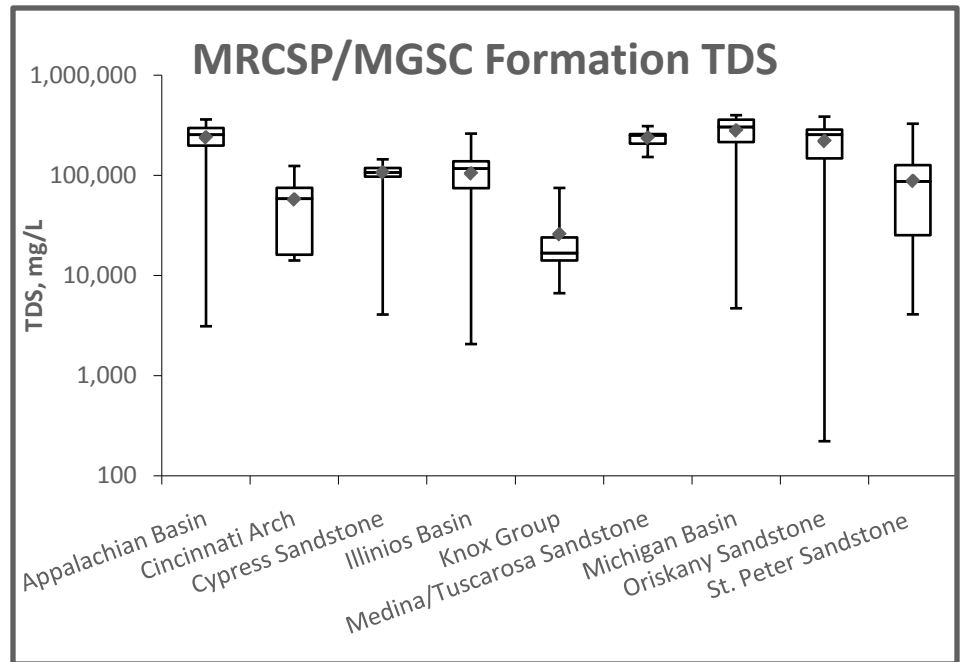
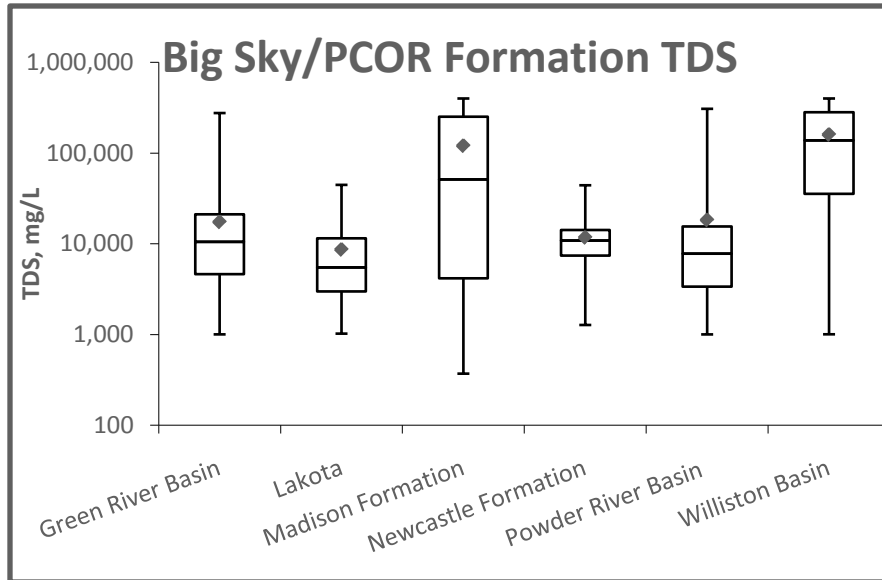
Saline Brine Composition, Major Constituents



Saline Brine Composition, Minor Constituents



Regional Trends in TDS

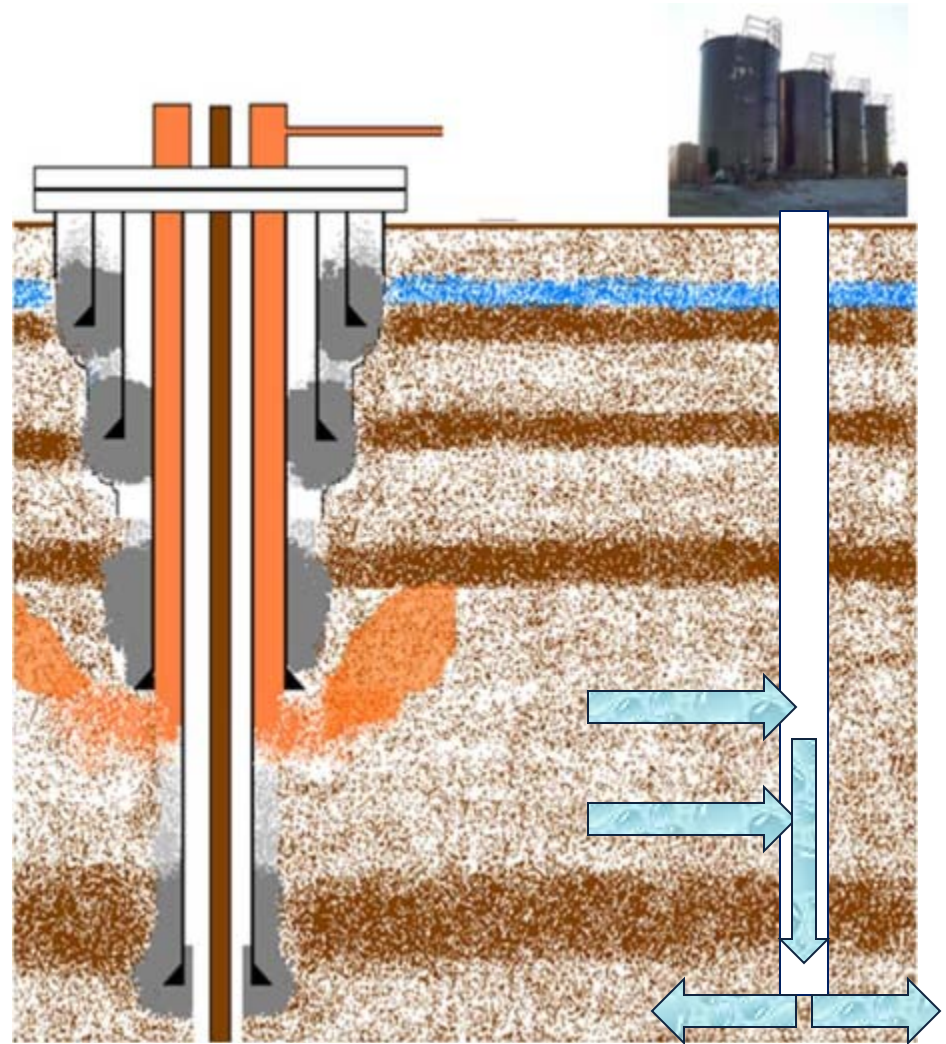


How Can the Water Be Managed?

- Inter-Formation Transfer
- Beneficial use
 - As is
 - After treatment
- Secondary uses
 - Energy
 - Mineral extraction
- Disposal

Minimize Water Managed at the Surface

- Inter-formation transfer
 - Need to ensure that water chemistry is compatible between formations



Injection for Recovering More Oil

- California
 - Nearly 25,000 produced water injection wells
 - 1.8 billion bbl/year total injection
 - 900 million bbl/year water flood
 - 560 million bbl/year steam flood
 - 360 million bbl/year injection for disposal



Texas

- 38,540 wells permitted for enhanced recovery
 - 5.3 billion bbl/year
- 11,988 wells permitted for disposal
 - 1.2 billion bbl/year



Treatment Technologies for TDS/Salt Removal



- Membrane processes
 - Filtration
 - Reverse Osmosis



- Thermal distillation



- Ion exchange



Industrial Use

- Cooling water makeup
- Enhanced geothermal systems
- Use in drilling fluids or hydraulic fracturing fluids
- Dust control
- Other



Agricultural Use

- Irrigation
- Livestock and wildlife watering
- Managed wetlands



Source: USDA



Source: USFWS



Source: USFWS



Opportunities for Secondary Uses

- If hot enough, can generate geothermal energy
 - RMOTC trial
 - Borealis Geopower project in Canada
- Mineral extraction
 - Li
 - others

Options for Disposal of Extracted Water

- Discharge
 - Probably only practical when located near the ocean
- Injection to non-hydrocarbon producing formation
 - Injection of salt water is likely to face less stringent requirements than injection of CO₂
 - Would need clarification of UIC regulations
 - Would not automatically qualify for Class II injection well status
- Evaporation
- Offsite commercial disposal



What do the Economics Look Like?

- The cost of managing large volumes of extracted water can be a significant factor in the economic viability of a CCS project
- The total life-cycle cost includes:
 - The cost of constructing treatment and disposal facilities, including equipment acquisitions
 - The cost of operating those facilities, including chemical additives and utilities
 - Transportation costs , including pumping, piping, and trucking
 - The cost of managing any residuals or byproducts resulting from the treatment of produced water
 - Permitting, monitoring, and reporting costs
- Costs for managing produced water range from <\$0.01/bbl to >\$8.00/bbl
- Costs for managing extracted water should be comparable or higher, due to a possible lack of infrastructure

What are the Major Challenges?

- Cost
- Consistency of volume and characteristics
- Legal issues
 - Water rights
 - Permitting of new type of waste stream
- Others??

Final Remarks

- Water extraction is not required for CCS programs but may be selected to improve operations or ease permitting
- When water is extracted, the volume is likely to be quite large
- Management of extracted water poses significant costs and challenges
- There are various options available for managing extracted water
- In a water-short world, extracted water may have a role as a new water resource
- **QUESTIONS?**

