

Overview of Brine Extraction Storage Test (BEST) Projects Phase II



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November 30, 2016

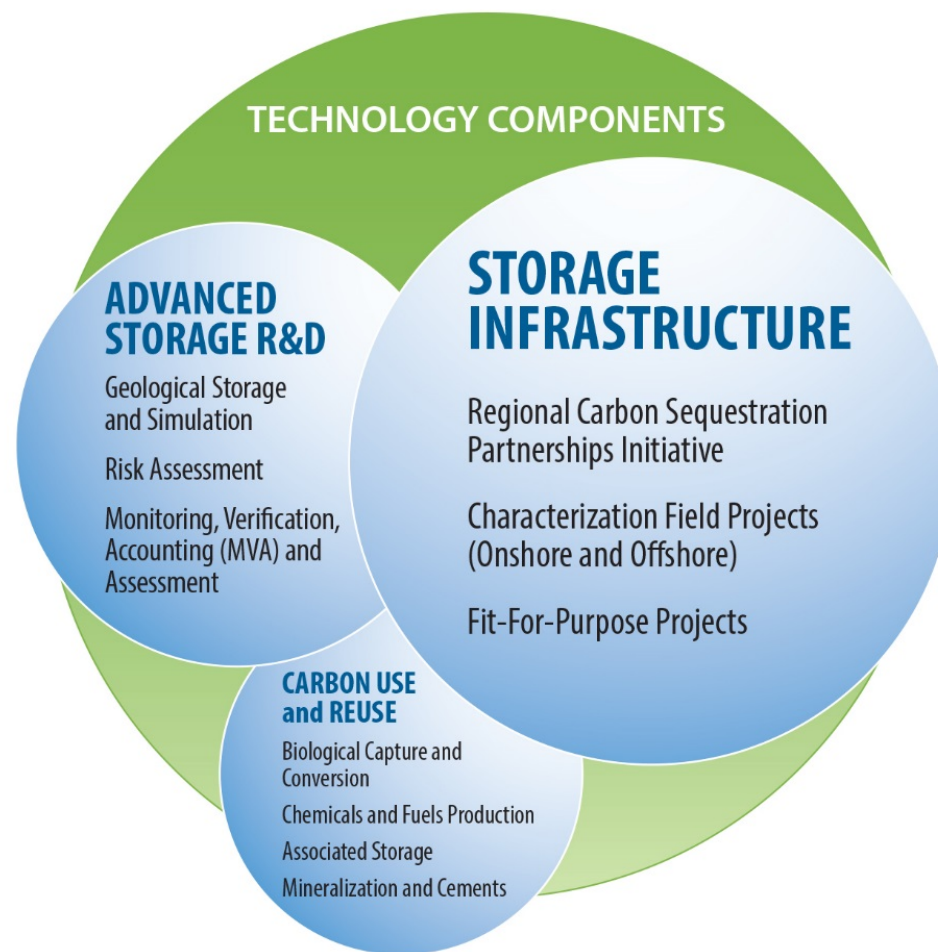


Solutions for Today | Options for Tomorrow



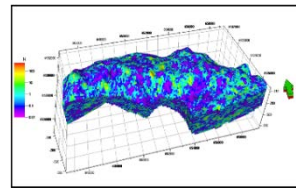
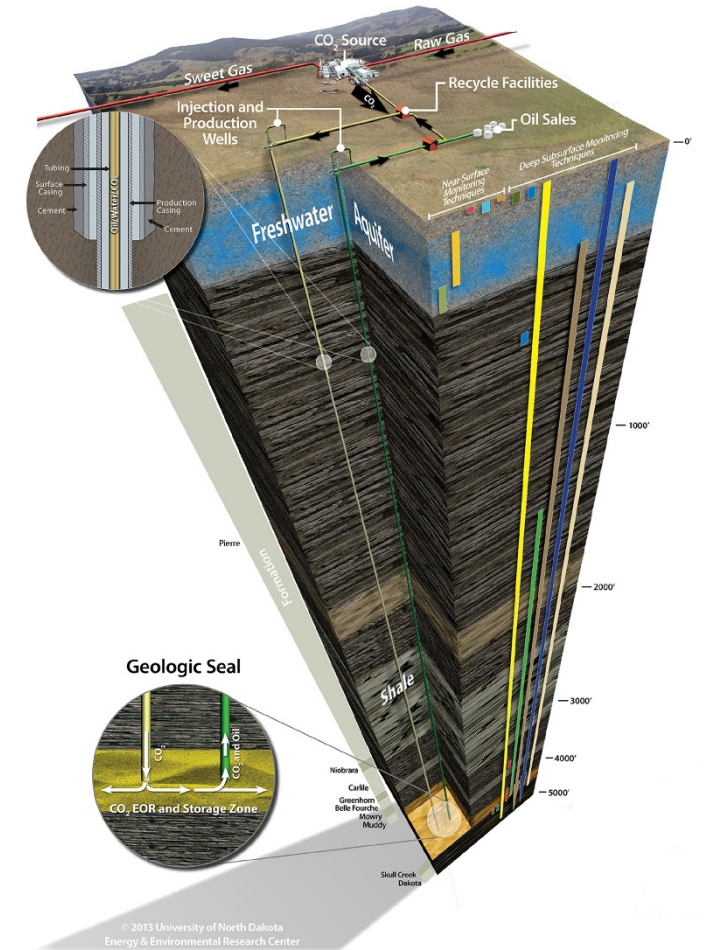
Carbon Storage Programmatic Structure and Technical Priorities

CARBON STORAGE PROGRAM

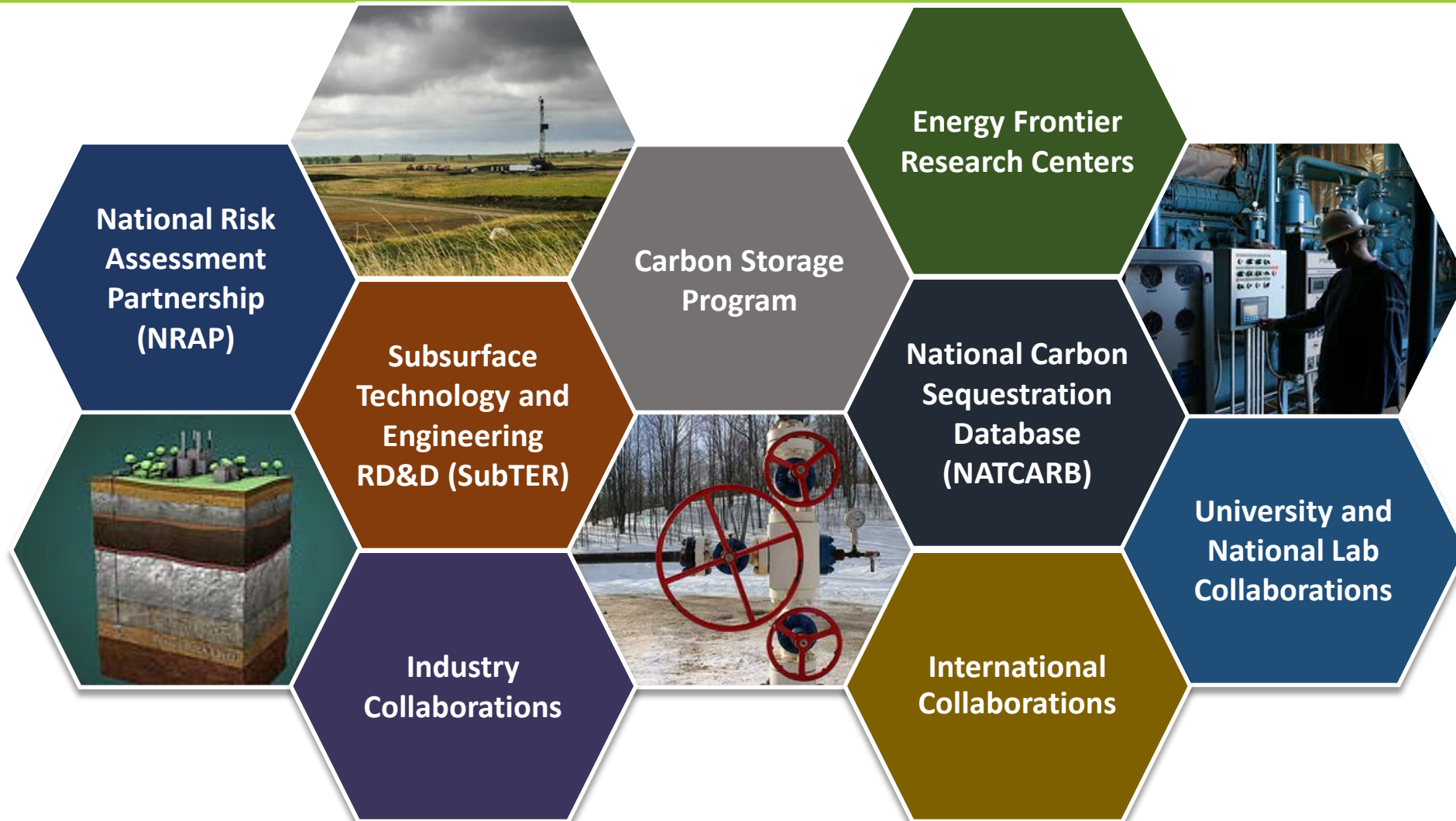


Carbon Storage Programmatic Structure and Technical Priorities

- Predicting and monitoring CO₂ plume and brine pressure front movement, stabilization, and impacts.
- Optimization of reservoirs for CO₂ storage capacity.
- Developing and validating risk-assessment strategies.
- Mitigating risks, such as leakage from old wells and induced seismicity.
- Carrying out (large-volume and Fit-for-Purpose) field tests for different storage types and depositional environments.

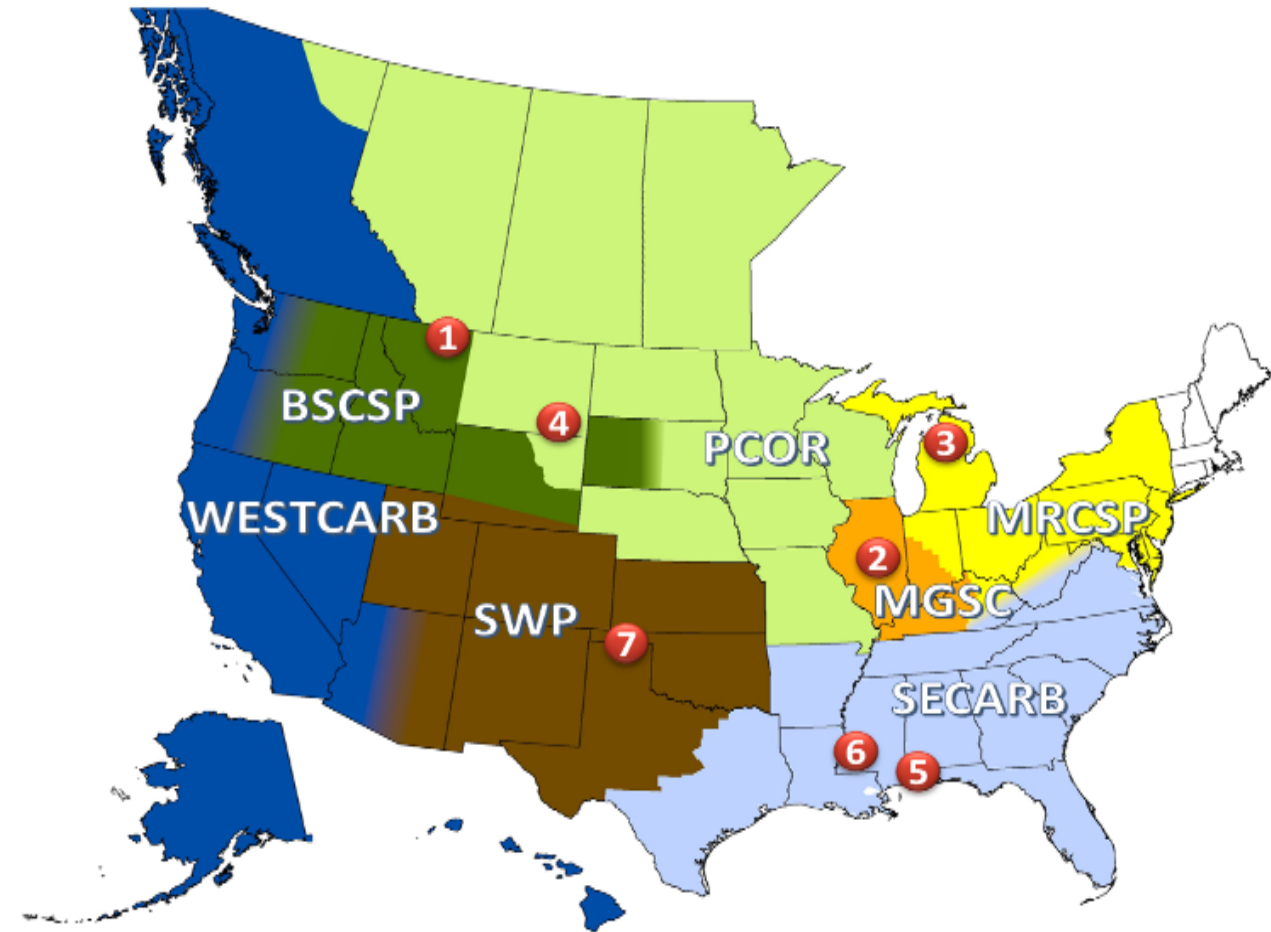


Collaborating to Address Technical Issues



RCSP Development Phase: Large Scale Field Projects With CO₂ Injection

Number on Map	Project Name	Project Type	CO ₂ Source	Geologic Basin	Metric Tons of CO ₂ Stored
1	Big Sky Carbon Sequestration Partnership–Kevin Dome Project	Saline Storage	Kevin Dome (natural)	Kevin Dome	N/A (no injection date)
2	Midwest Geological Sequestration Consortium–Illinois Basin Decatur Project	Saline Storage	ADM Ethanol Production Facility	Illinois Basin	999,215 (final stored and project in post-injection monitoring phase)
3	Midwest Regional Carbon Sequestration Partnership–Michigan Basin Project	Enhanced Oil Recovery	Core CO ₂ Services, LLC Natural Gas Processing Facility	Michigan Basin	596,282 (as of Sept. 30, 2016)
4	The Plains CO ₂ Reduction Partnership–Bell Creek Field Project	Enhanced Oil Recovery	Conoco Phillips Lost Cabin/Madden Natural Gas Processing Plant	Powder River Basin	2,982,000 (final stored and project in post-injection monitoring phase)
5	Southeast Regional Carbon Sequestration Partnership–Citronelle Project	Saline Storage	Southern Company's Plant Barry Coal-Fired Power Plant	Interior Salt Basin, Gulf Coast Region	114,104 (final stored and project in post-injection monitoring phase)
6	Southeast Regional Carbon Sequestration Partnership–Cranfield Project	Enhanced Oil Recovery/ Saline Storage	Jackson Dome (natural)	Interior Salt Basin, Gulf Coast Region	4,743,898 (final stored and project in post-injection monitoring phase)
7	Southwest Carbon Sequestration Partnership–Farnsworth Unit Project	Enhanced Oil Recovery	Arkalon Ethanol Plant (Liberal, KS) Agrium Fertilizer Plant (Borger, TX)	Anadarko Basin	490,720 (as of Sept. 30, 2016)

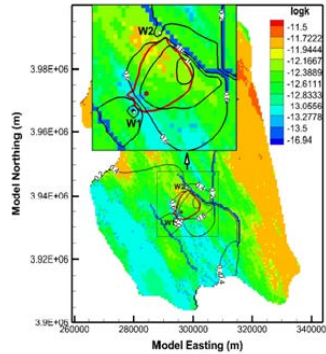


Storage Program BEST Projects – Phase I

Fit-for-Purpose Field Project: Developing and Validating Pressure Management and Plume Control Strategies through a Brine Extraction Storage Test (BEST)

Research objectives:

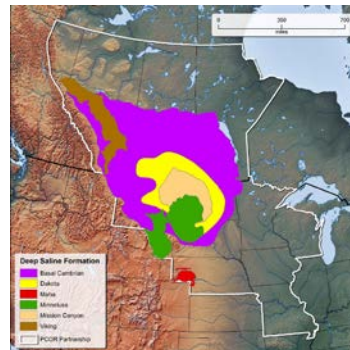
- ❖ R&D projects for managing formation pressure plumes as well as measuring/monitoring the movement of the differential pressure and CO₂ plumes in the subsurface for future saline CO₂ storage projects.
- ❖ Brines extracted shall be utilized as a part of a test-bed for brine treatment technologies
- ❖ Projects completed in two phases:
 - **Phase I** – Gap and water LCA for brine technologies and develop plans for field project
 - **Phase II** – Validation testing employing water/brine injection
- ❖ **Phase I - 5 projects were awarded, with a total budget of \$9.35 million (Cost share = \$2.15 million)**



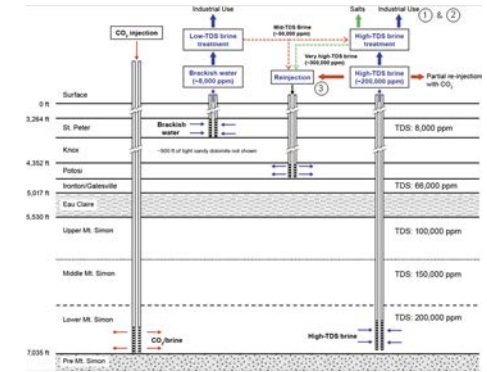
Electric Power Research Institute – Gulf Coast field demonstration at a flagship power plant site: Assessment of opportunities for optimal reservoir pressure control, plume management and produced water strategies



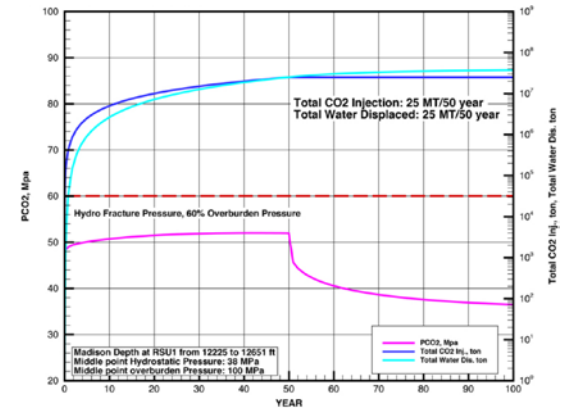
University of Texas at Austin– Pressure management and plume control strategies through a brine extraction storage test (BEST) at the Devine Test Site (DTS) in Texas



EERC, University of North Dakota – Developing and Validating Pressure Management and Plume Control Strategies in the Williston Basin through a Brine Extraction and Storage Test



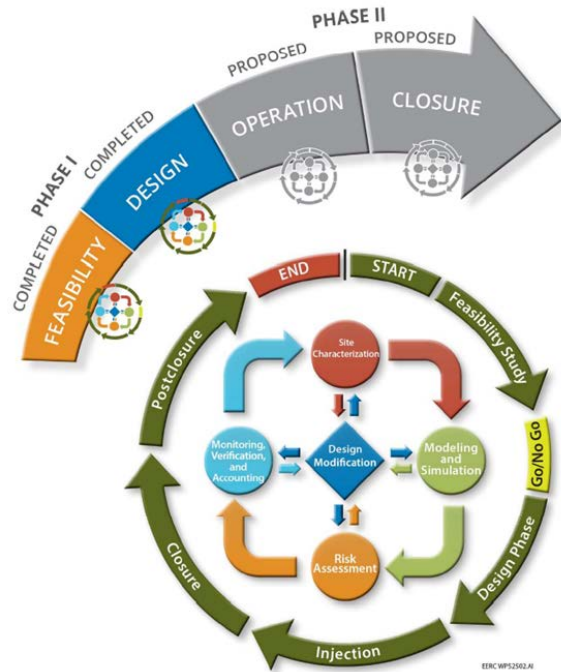
Illinois State Geological Survey – Brine extraction and treatment strategies to enhance pressure management and control of CO₂ plumes in deep geologic formations



University of Wyoming – Field demonstration of an active reservoir pressure management through fluid injection and displaced fluid extraction at the Rock Springs Uplift

BEST Projects – Phase II

Fit-for-Purpose Field Project: Developing and Validating Pressure Management and Plume Control Strategies through a Brine Extraction Storage Test (BEST)



Research objectives:

- ❖ R&D projects for managing formation pressure plumes as well as measuring/monitoring the movement of the differential pressure and CO₂ plumes in the subsurface for future saline CO₂ storage projects.
- ❖ Brines extracted shall be utilized as a part of a test-bed for brine treatment technologies
- ❖ Projects completed in two phases:
 - **Phase I** – Gap and water LCA for brine technologies and develop plans for field project. This phase has been completed under Phase I funding.
 - **Phase II** – Validation testing employing water/brine injection



Energy & Environmental Research Center –

- Validate pressure management and plume control strategies at the Nuverra Environmental Solutions operated salt water disposal facility in Johnsons Corner, ND
- Injection and extraction scenarios will be varied to study pressure response.

Electric Power Research Institute –

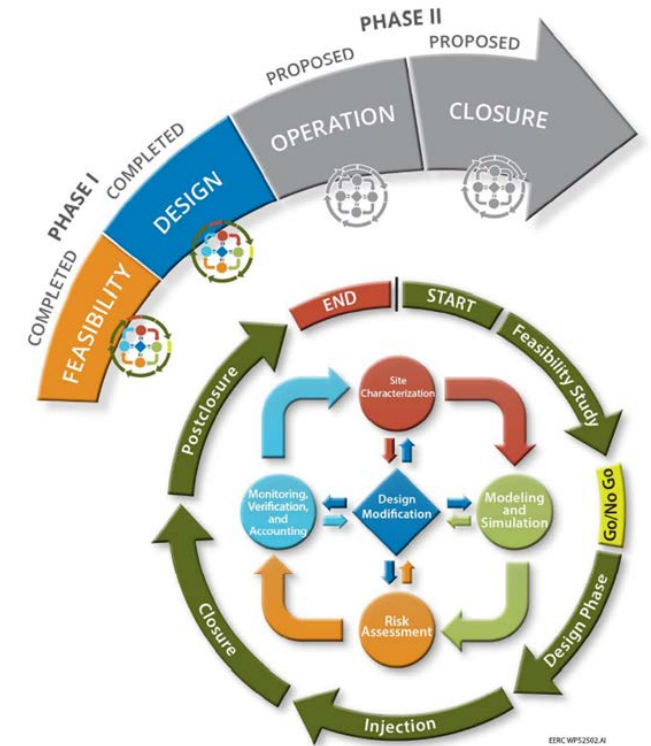
- Injection and extraction test at Plant Smith Generating Station, Bay County, Florida.
- Perform injection/extraction using passive and active pressure management plans to optimize plume conditions.

Energy & Environmental Research Center (EERC), UND



Developing and Validating Pressure Management and Plume Control Strategies in The Williston Basin Through A Brine Extraction and Storage Test (BEST) – Phase II

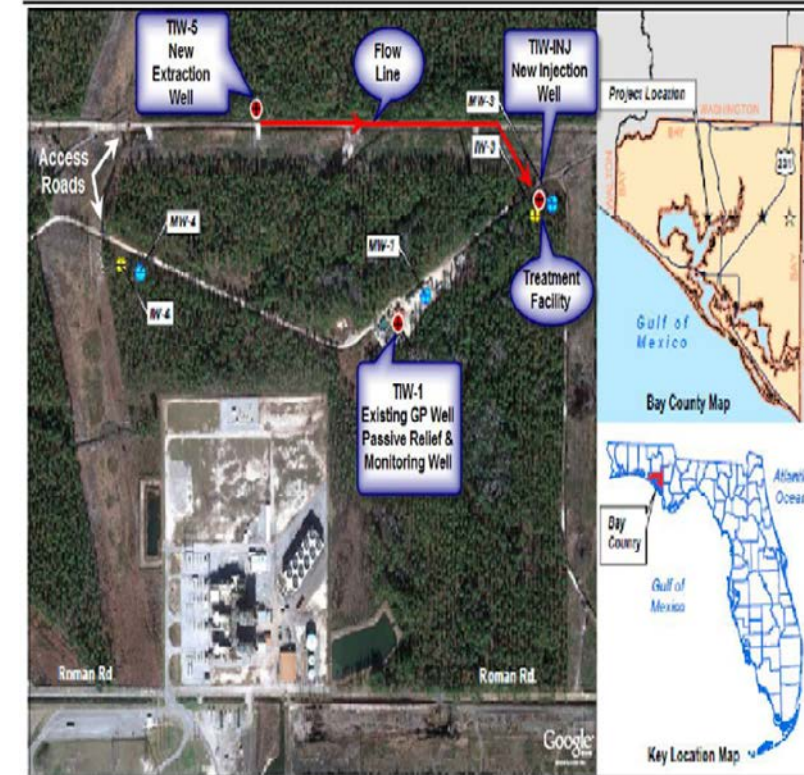
- **Partners:** Nuverra Environmental Services; Schlumberger Carbon Services; Computer Modelling Group Ltd. (CMG)
- **Project Location:** Johnsons Corner, ND
- **Current Field Activities:** Active saltwater disposal (SWD) site. Currently two commercial SWD wells injecting brine approximately 300,000 ppm into the Inyan Kara.
- **Wells Proposed:** Addition of an extraction well from the Inyan Kara (expected TDS approximately 5,500 ppm) and an injection well into the Broom Creek.
- **MVA Proposed:** Chemical tracers; borehole-to-surface electromagnetics (BSEM); well head and bottom hole pressure; integration with history matched reservoir model
- **ARM Plan Design:** Initially a variety of scenarios including injection and extraction pulses at varying rates at varying wells to see pressure responses at the wells and allow for pressure restoration to normal field operating conditions in between. This is followed by more sustained injection/extraction periods.
- **Brine Treatment Proposed:** Well designed indoor surface facility with pretreatment options that can be utilized or bypassed. Ability to blend brines to desired TDS and storage tanks to allow variability of flow rates. Includes wastewater collection and independent water quality testing pre and post treatment.



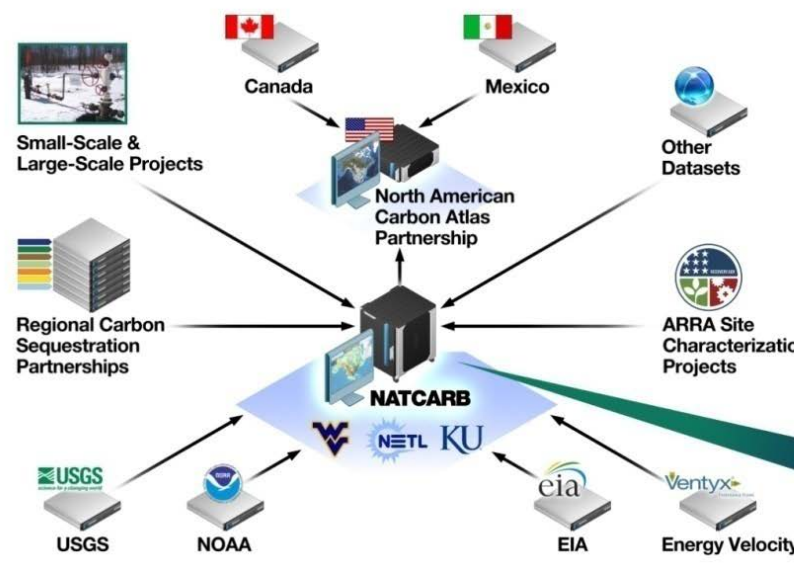
Electric Power Research Institute (EPRI)

Phase II Field Demonstration at Plant Smith Generating Station: Assessment of Opportunities for Optimal Reservoir Pressure Control, Plume Management and Produced Water Strategies

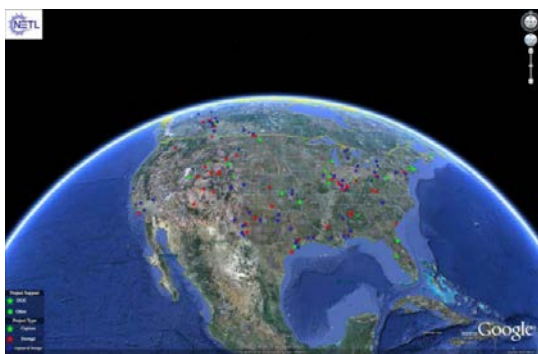
- **Partners:** Advanced Resources International; Lawrence Berkeley National Laboratory; CH2M; Southern Company Services and its subsidiary Gulf Power Company
- **Project Location:** Bay County, Florida (near Panama City)
- **Current Field Activities:** Plant Smith with existing injection well permitted by Gulf Power to dispose of ash-pond and reclaimed blow-down water.
- **Wells Proposed:** Addition of an injection well (Lower Tuscaloosa) and an extraction/monitoring well (Lower Tuscaloosa) with anticipated TDS of 166,000 ppm. Passive relief would be conducted in the existing injection well (completed in the entire Lower Tuscaloosa/Lower Cretaceous formations)
- **MVA Proposed:** Downhole temperature and pressure measurements; cross-well and borehole to surface electromagnetics; InSAR
- **ARM Plan Design:** Pressure management plans utilize both passive and active relief in order to optimize the plume conditions. The preliminary modeling shows that by doing both, the pressure management is much more efficient. LBNL recently developed and applied rapid optimization methods for reservoir pressure control, which will be used.
- **Brine Treatment Proposed:** Outdoor facility (gravel pad) with utility connections for electricity, cooling, and service water, and collection equipment for produced water. Area lighting will be provided along with portable toilet facilities. Includes independent water quality testing pre and post treatment.



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