CarbonSAFE Echo Springs

Carbon Storage Assurance Facility Enterprise (CarbonSAFE) Phase II-Storage Complex Feasibility

PROJECT AWARD #: DE-FE0032448

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Carbon Management Research Project Review Meeting
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CARBON TRANSPORT AND STORAGE BREAKOUT SESSION 1
Tuesday 1:50PM, Ballroom B

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Acknowledgement and Disclaimer

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Project Overview

Project Partners

Summary: CarbonSAFE Echo Springs will investigate a saline carbon dioxide (CO_2) storage (permanent carbon disposal) option for current and future industry in the Echo Springs, Wyoming area.

Project Award #: DE-FE0032448

Duration: 2 years

Project Background

Project Vision

Project location

- South Central Wyoming, on the Greater Green River Basin's eastern margin.

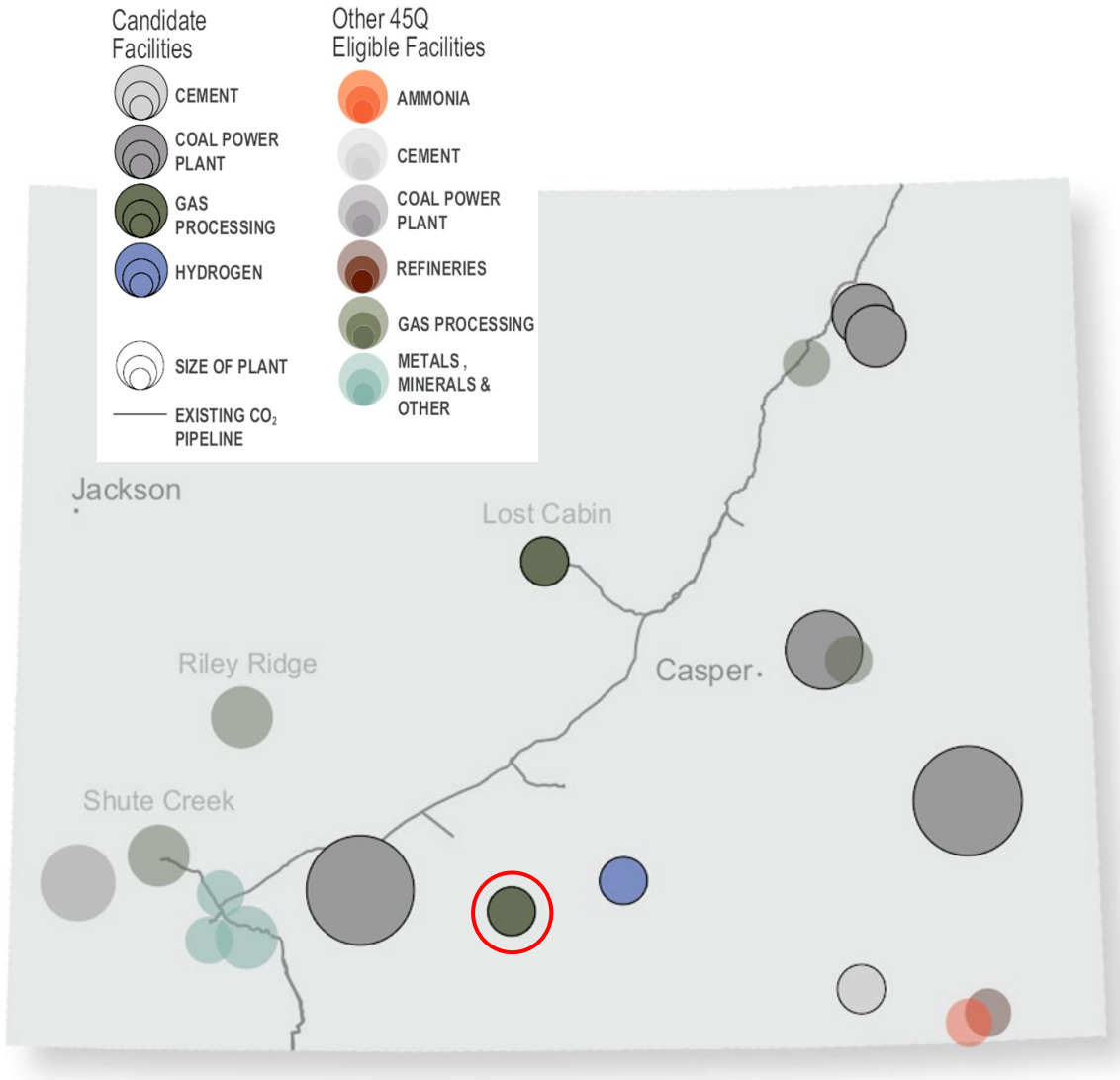
Project Background

- Capture from the initial source

- Tie- in other sources nearby and CO_2 pipelines

Importance of project towards advancing DOE Program Goals

- This project could become commercially-motivated quickly.



POTENTIAL CANDIDATE FACILITIES FOR CAPTURE WITH ANNUAL EMISSIONS

Facility Name	Location	Industry	Total Facility CO2 Emissions thousand tons	CO2 Captured Target thousand tons	Theoretical Capture Cost $/ton *(Draft - Do Not Cite)*
Jim Bridger	Point Of Rocks	Coal Power Plant	11,762	1,600	$57
Dave Johnston	Glenrock	Coal Power Plant	5,008	1,600	$57
Dry Fork Station	Gillette	Coal Power Plant	3,283	1,600	$57
Laramie River	Wheatland	Coal Power Plant	11,203	3,200	$54
Wyodak	Gillette	Coal Power Plant	3,067	1,600	$57
Lost Cabin	Lost Cabin	Gas Processing	733	642	$11
Mountain Cement	Laramie	Cement	635	574	$56
Echo Springs Gas Plant	Wamsutter	Gas Processing	538	205	$14
Sinclair Oil Corporation	Sinclair	Hydrogen	1,033	194	$49

Source: Great Plains Institute (phosphate not shown)

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A team member is an expert in pipeline transport:

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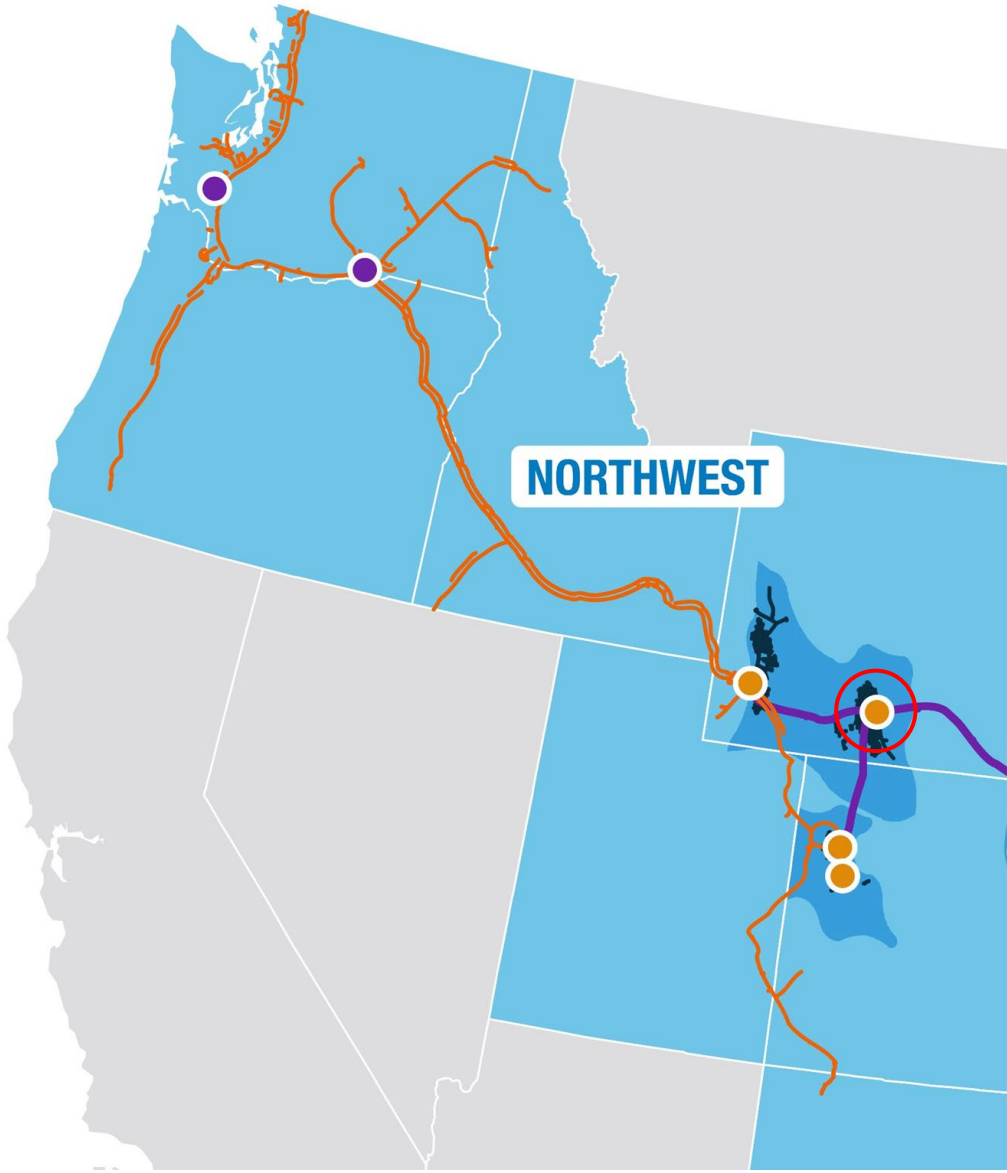

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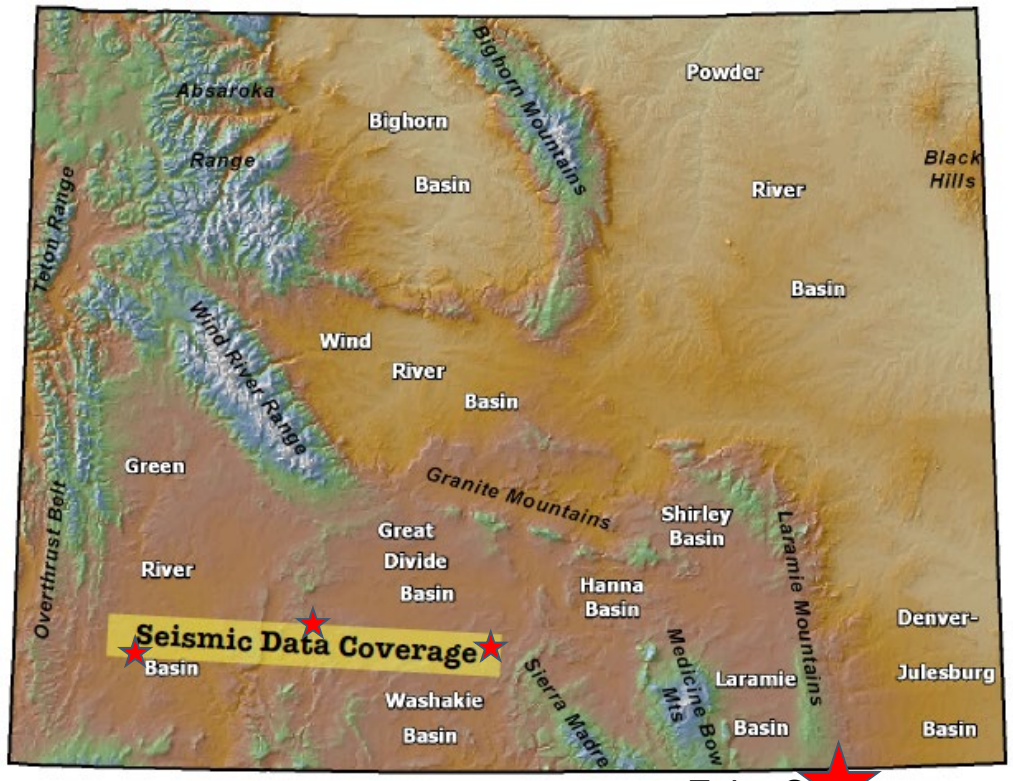
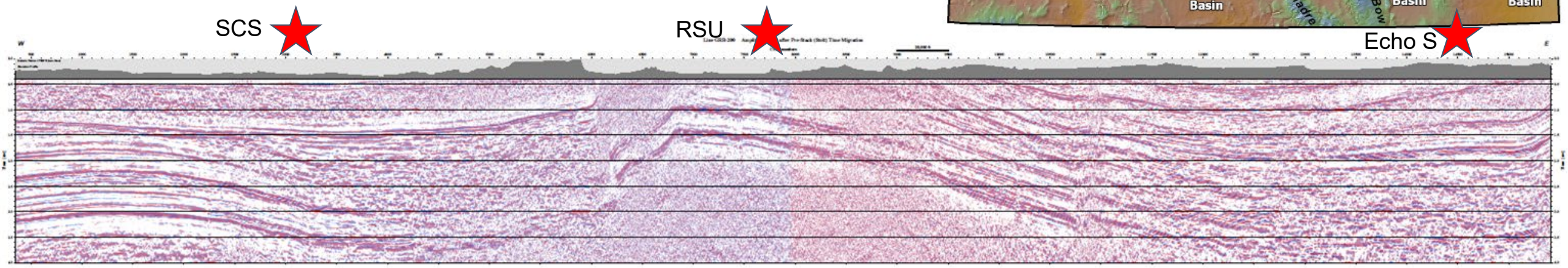


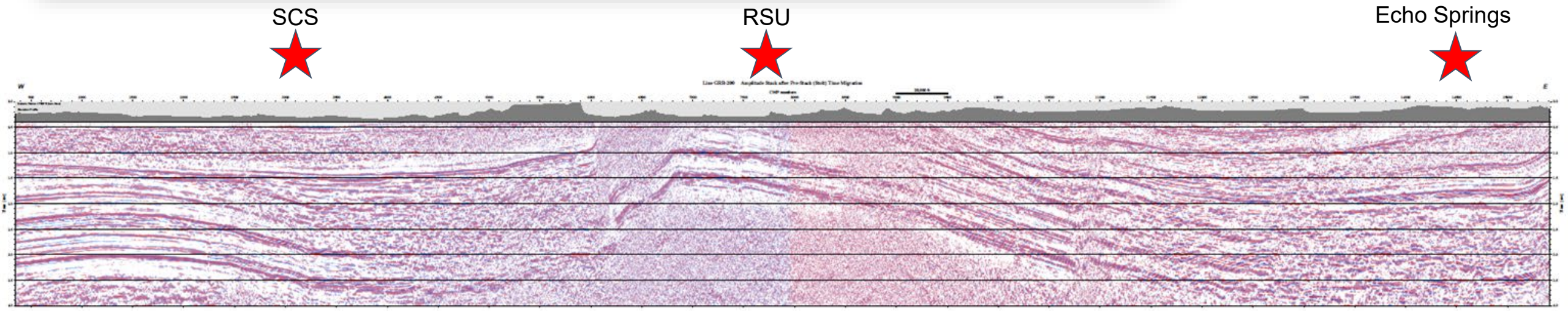


Wyoming elevation map showing major gas-producing sedimentary basins. Approximate location of the regional 2-D seismic lines is shown in the South-West corner.

Studying the Eastern GGRB

An understudied area with new trade-offs

- SCS and RSU targeted structural traps
  - Can near-flat structure also work?
  - What happens at depth greater than existing wells?
- Do the savings from starting with a Gas Plant allow deeper targets?
- Is it better to go deep and avoid P&A challenges?



Technical Approach and Project Scope

Project Execution Plan

- *Task 1.0: Project Management and Planning*
  - *Standard*
- *Task 2.0: Site Specific Characterization & Assessment of the CO_2 Storage Complex.*
  - *Gather datasets, permit other work, and model the complex.*
- *Task 3.0: Preliminary Project Risk assessment with Mitigation & Management Plans*
  - *Risk Assessments, partner with NRAP, handling combinations of S-T-S*
- *Task 4.0: Plan for Subsequent Detailed Site Characterization & UIC Class VI Permitting*
  - *Future Work and Commercialization Needs*
- *Task 5.0: Project Technical & Economic Feasibility Assessment, Including Conceptual-Level Design Study for CO_2 Transport.*
  - *Consider modifications of the site, and pipelines to link to those*
- *Task 6.0:Community Benefits*
  - *CBOO, Oil & gas knowledge in the area, Williams' existing commitments*
- *Task 7.0:Well Design, construction, and sampling*
  - *Industrial Standard, but with research elements/sampling*

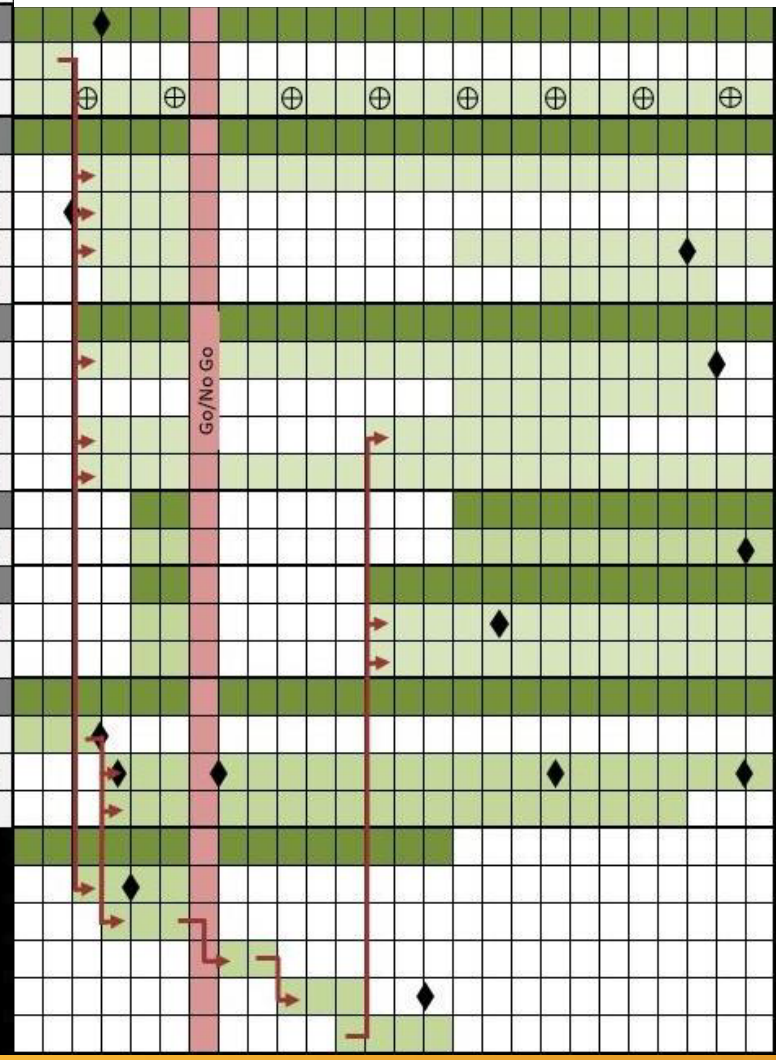
Project schedule

We are nearing the end of negotiations. Our plans are still the same, just shifted back a bit.

Drilling is the exception, and due to winter it may need to be shifted earlier/later.

This project will show if injection at Echo Springs should be Shallow or Deep, and if the

Echo Springs		Dependencies						
Task	Title	1	2	3	4	5	6	7
1	**Project Management & Planning**							
	Revise Project Management Plan							
	FY Quarterly Report due							
2	**Site Specific Characterization & Assessment**							
2.1	Comprehensive datasets	X		X			X	X
2.2	Permitting activities	X					X	X
2.3	Storage site modeling	X				X	X	X
2.4	Data provided and received	X		X		X	X	X
3	**Preliminary Project Risk Assessment**							
3.1	Risk Assessment: Non-technical	X	X			X	X	
3.2	Risk Assessment: Technical	X	X			X		X
3.3	Collaboration with NRAP tool developers	X	X					X
3.4	CO2 Management, transport, and sourcing	X					X	X
4	**Plan for Site Characterization & UIC Permitting**							
4.1	CarbonSAFE Phase III preparation	X	X	X			X	X
5	**Project & Technical Feasibility Assessment**							
5.1	Technical and Economic feasibility	X	X	X			X	X
5.2	CO2 Transport concept	X		X			X	
6	**Community Benefits Plan**							
6.1	Updates and development of the CBP Plans	X						
6.2	CBP Implementation and Milestone Achievement	X	X	X		X		X
6.3	Stakeholder Input	X						
7	**Well Design, Construction, and Sampling**							
7.1	Well design	X					X	
7.2	Well pad staging	X	X				X	
7.3	Rig-up, spudding, and surface segment	X	X				X	
7.4	Research segment, logging, and sampling	X	X				X	
7.5	Site-closure	X	X			X	X	



Project risks

Key challenges exist at:
Permitting,
Drilling,
Downhole-collection, and
Geologic Modeling

Decision Point	Go/ No-Go?	Circumstances Affecting the Decision
Permitting	Yes	One or more permits could be denied. The team must remediate and resubmit
Drilling	No	Technical challenges, mechanical failures, drilling speed, environmental protection, costs.
Down-Hole Data Collection	No	Down-hole data collection incomplete due to tool malfunction or analytical loss
Geologic Model complete	No	Geologic model scaled and runnable in reasonable time on CEGR's modeling computer

Perceived Risk	Risk Rating: Probabilit	Impact	Overall	Mitigation/Response Strategy
Financial Risks:				
Inflation continues to rise and is passed on to the consumer (us) rather than being absorbed by the driller/vendors.	H	M	M	The Task 7 team has managed drilling in dozens of Texas wells, as well as two UIC-Class VI wells in Wyoming. The team is experienced with cost-saving measures for drilling, and if needed the Team could discuss with regulators leaving the lowest segment of the well temporarily uncased in anticipation of future use. Accelerating the schedule to perform drilling as early as possible in the first year would also reduce the effects of inflation.
Cost/Schedule Risks:				
Drilling to the Nugget Sandstone is prohibitively costly	M	H	M	The Team has six (or more) targets and, given a reasonable number of injectors, only expect to need two or three to be suitable for the project to succeed. Therefore, the Team can stop short of Nugget. This comes at the cost of possibly excluding one of the best reservoirs in the deepest section of the well. A further mitigation comes from William's ability to provide additional capital, which may allow full performance even if this risk occurs.
Demand for drillers exceeds supply, and none are available	H	L	L	By issuing an RFP very early in the project, the team will have maximum time to negotiate schedule and reserve time on a driller's calendar. Also, Williams may choose to add this well to an existing drilling campaign in the area. The trade-off is that the Team may have to use over-powered equipment intended for directional drilling for a simple vertical test well.
Technical/Scope Risks:				
All or almost all of the six reservoirs are found to have inadequate geologic characteristics	L	H	L	Although it is probable that less than all 6 reservoirs will be suitable it is highly unlikely that no reservoir will be suitable. By allowing for impromptu new reservoirs (potentially Lakota or Dakota), this risk is reduced. In the worst case, the Project could re-locate within a reasonable radius based on how the reservoirs were unsuitable and for what reason.
Management, Planning, and Oversight Risks:				
DOE exercises oversight at a go/no-go decision point	M	H	M	The Team will attempt to perform the project to the SOPO and PMP specifications, if DOE indicates oversight concerns the PIs will immediately meet to produce a plan to address the concern prior to the Go/No-go decision point. If a delay is issued, the Team will use that delay to diligently perform corrective action. If the No-go is final, and in the worst case ends the project, the Team must accept this finding.

Except of High Probability or Impact Risks Table

As Negotiations have Progressed some of these risks have moderated.

The mitigation plans remain the same.

Current Status

THE WORLD NEEDS MORE ADVENTUROUS SPIRIT.

Current Project Status

Still in Negotiation

- At the moment no funded work

Found/transferred old Datasets

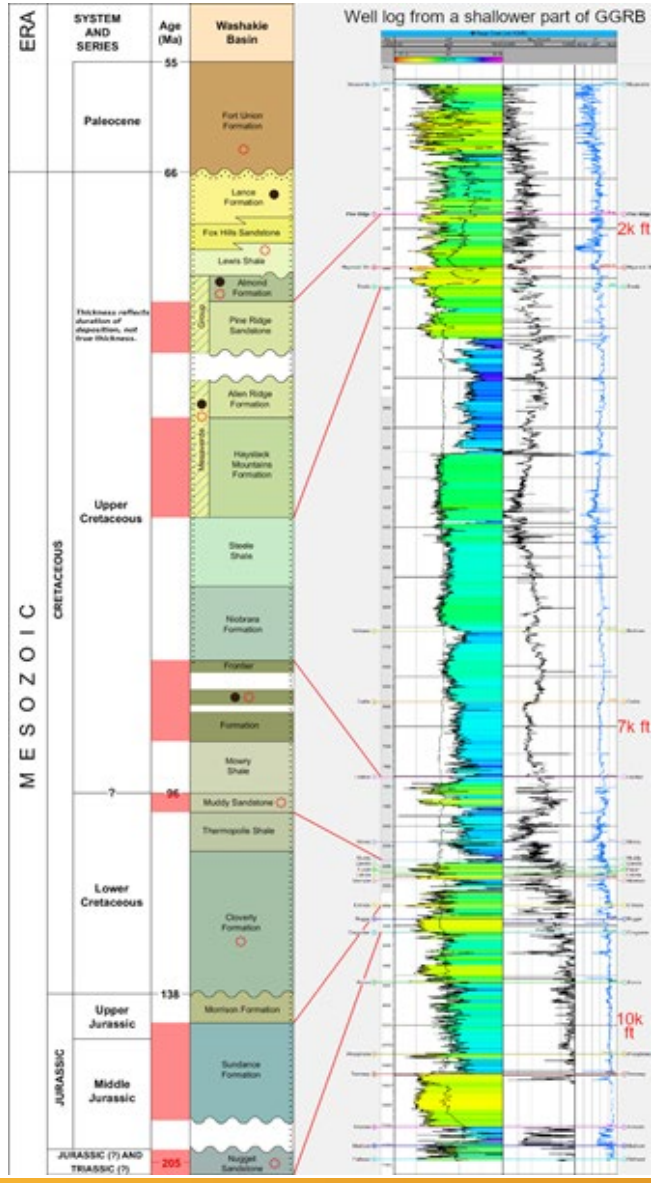
- UWyo - An old seismic line with permissive interpretation sharing courtesy of WSGS and Wyoming companies
- Williams - NDAs in place for dataset sharing

Limited checking of the target depths

- ~5,000 deeper than the margin logs.
- This may open a seventh formation option: Lower Lewis
- Supports Williams' - Vendor selection and Bidding

Engineering of capture plans (not in this project)

- A glycol unit seems adequate for dehydration

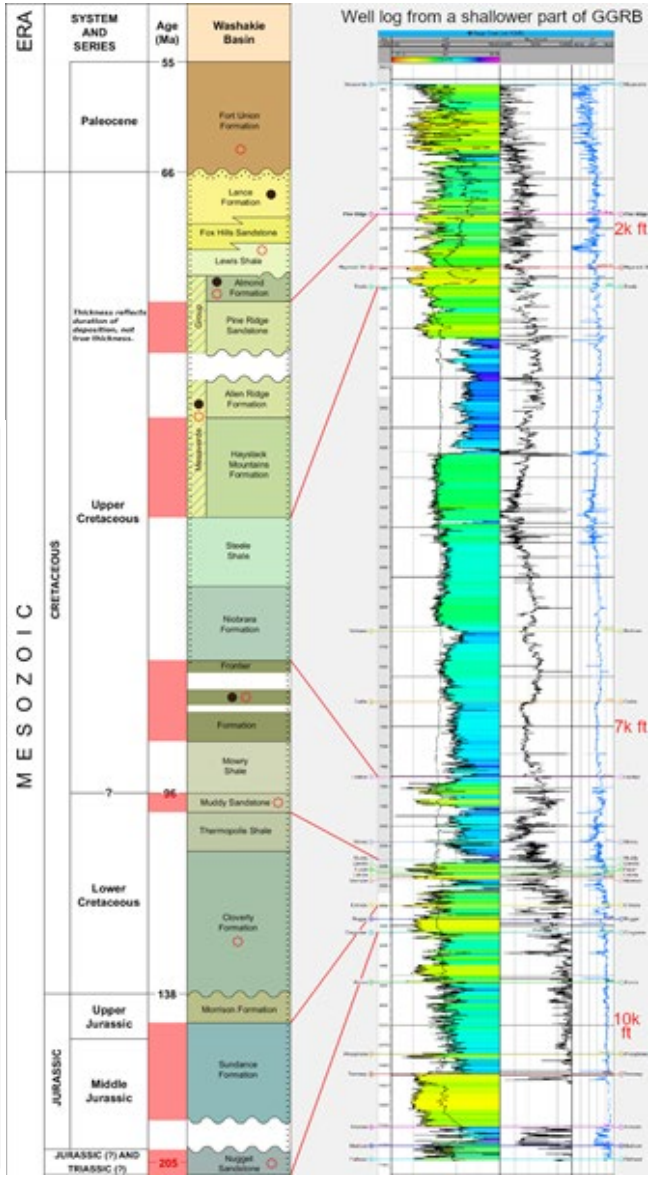


Key Findings and their effects

If the site is 5,000ft deeper we'll still do the Stratigraphic Test-well (aka "appraisal well") in the same place. The later-phase injector may move to a shallower part of the basin, or if we go after the Lower Lewis, a deeper part.

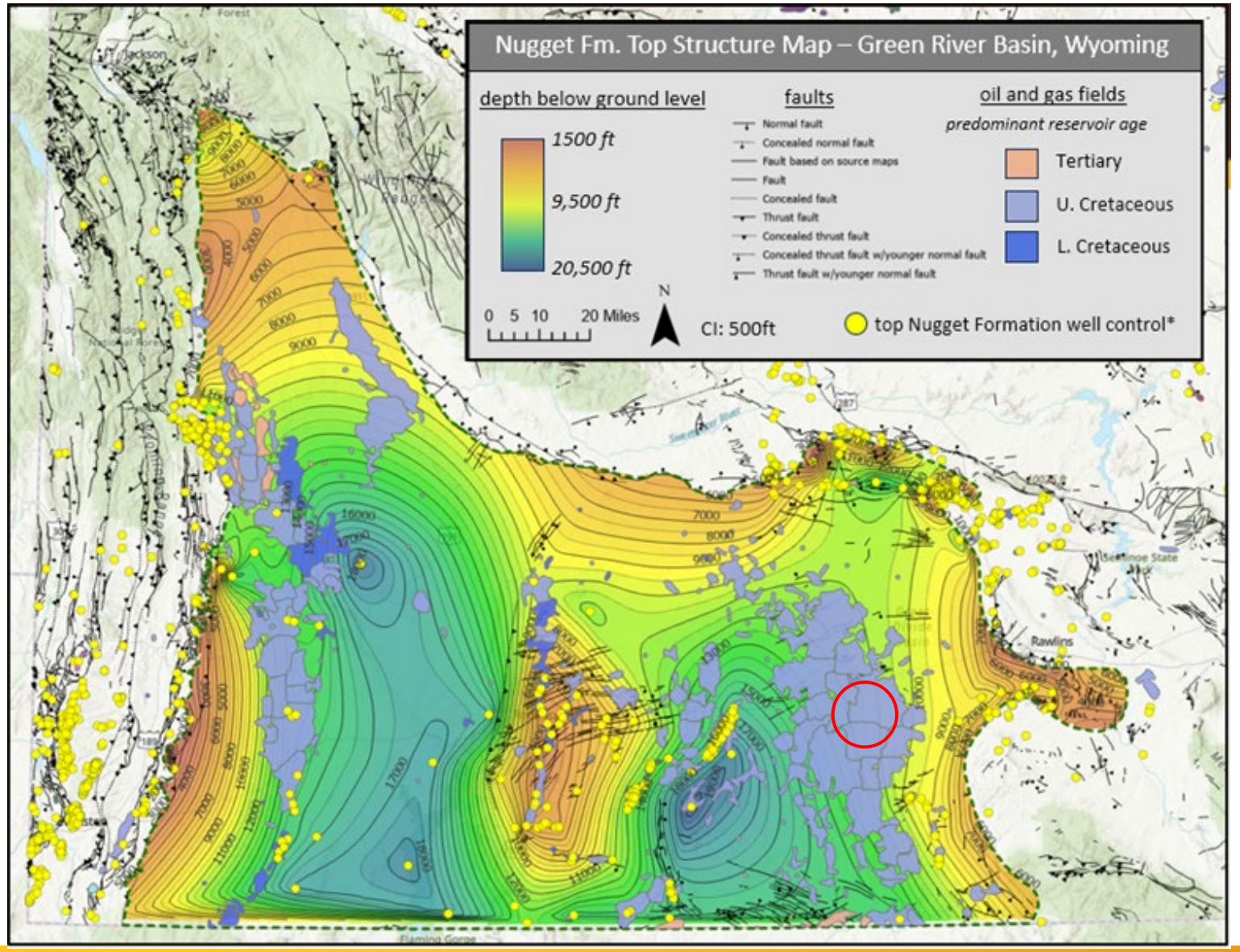
In either case we are now expecting to either be cutting the first or last formations in our list. It is not likely we will find success in all seven.

Formation	Average Thickness	Average Porosity	P10 Metric Tones/mi^2	P50 Metric Tones/mi^2	P90 Metric Tones/mi^2
Pine Ridge	84	19%	7,386,374	13,974,221	23,955,807
Haystack Mt	170	18%	14,161,845	26,792,679	45,930,307
Frontier	159	10%	7,358,606	13,921,686	23,865,748
Muddy	39	12%	2,165,929	4,097,704	7,024,635
Dakota	39	7%	1,263,459	2,390,327	4,097,704
Lakota	35	7%	1,133,873	2,145,165	3,677,427
Entrada	15	3%	208,262	394,010	675,446
Nugget	139	12%	7,719,594	14,604,637	25,036,520



Basin Map: GGRB

- The Greater Green River Basin is rich in oil and gas, mostly in the Upper Cretaceous rock formations.
- Success would allow for an even lower carbon footprint for Wyoming's natural gas sales.
- Responsibly sourced natural gas with even lower carbon footprint commands a premium on the northwestern market.
- This project is on the border of Sweetwater and Carbon counties with direct job-creation benefits flowing to Rawlins and Rock Springs.



Community Benefit and Impacts

CBP Strategy

Local and regional stakeholders understand Oil and Gas, which supports government operations and private jobs

- Leads to very savvy local people who ask great questions using O&G analogies
- Responsible Gas gives a market-place "tag" to methane which has a lower footprint than other methane. This is an incentive for CCS in the GGRB.

Identify key stakeholders in surrounding communities

- Work to engage stakeholders to share knowledge about CO_2 storage
- Solicit feedback to help guide project-specific engagement
- Engage with regional regulatory entities

Sharing and soliciting feedback from the local communities

- Build advocacy for clean energy projects
- Collaboratively address non-technical challenges to project development

Stakeholder and Community Outreach

- Incidental questions about CCS during the first UWyo SER Energy Road Show.
  - Illustrates the importance of being present
  - Personal rapport and face-to-face time
- The word gets out even if you are doing negotiations.
  - Opportunity in this case, but could have been a risk
- ***Outreach is strategic for clean energy project acceptance***

Lessons Learned

Lessons Learned

Project is under negotiation, but:

Have representatives everywhere (or educate members of your own organization enough) to handle questions during open forums for other projects

Interpreted seismic -even 2D- allows much better assessment of depth than the closest neighboring well when that well has been affected by facies changes and the basin margin

Partnerships with industry are essential to both momentum and adapting to unforeseen events.

Next Steps

Next Steps in Phase II

1. Study the transferred data.

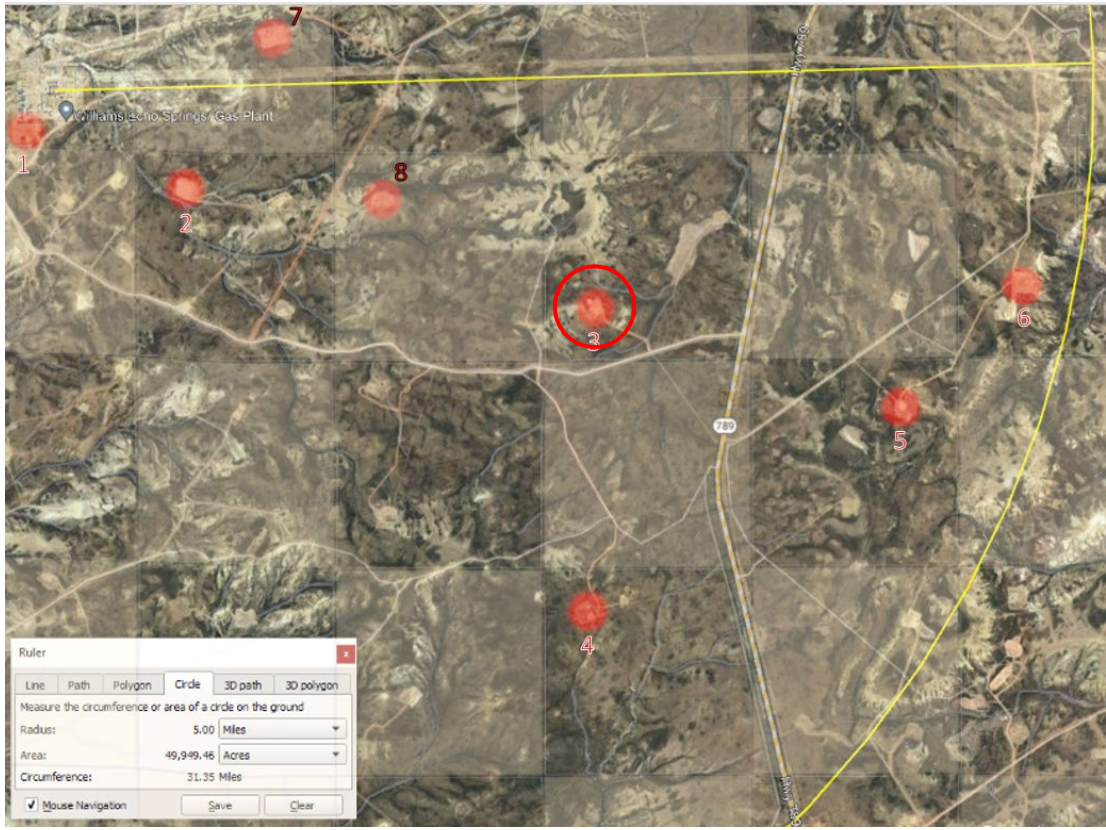
2. Start permitting for the appraisal well

1. Select Driller for field program

1. Select sample locations and if-then logic for field decisions.

1. Initiate the CBP

1. Drill the Stratigraphic Well



Questions?