

Wyoming CarbonSAFE: Accelerating CCUS Commercialization and Deployment at Dry Fork Station and the Wyoming Integrated Test Center

PROJECT AWARD #: DE-FE0031891

Dr. J. Fred McLaughlin, Scott Quillinan, Kipp Coddington
University of Wyoming

U.S. Department of Energy
National Energy Technology Laboratory
Carbon Management Project Review Meeting
August 15 - 19, 2022
CARBON TRANSPORT AND STORAGE SESSION, 1:40pm



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THE WORLD NEEDS MORE COWBOYS.

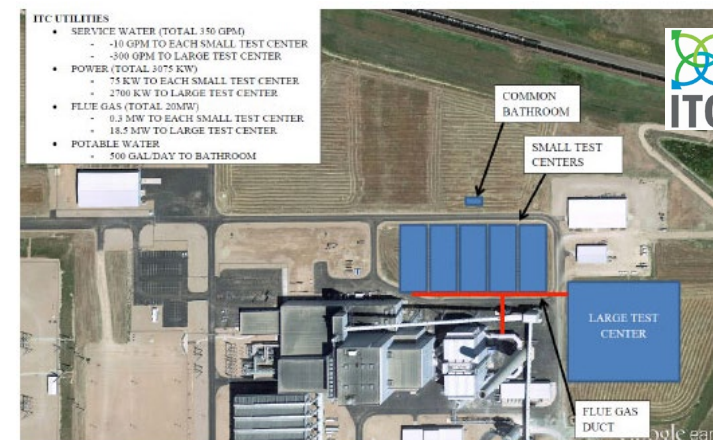
Project Overview

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ADVENTUROUS SPIRIT.*

Project Overview: Wyoming CarbonSAFE Phase III

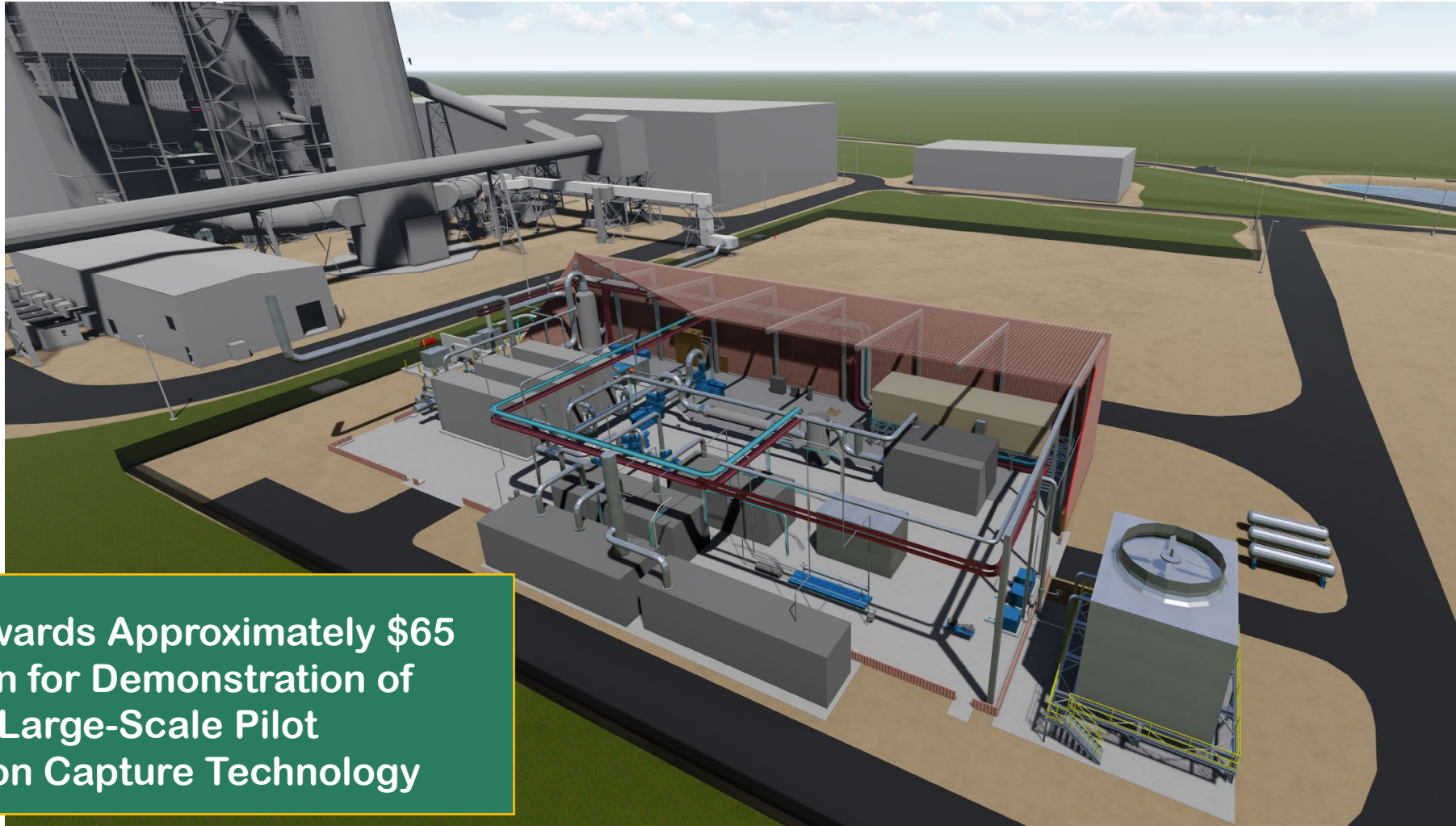
Located at:

- Dry Fork Station (Basin Electric Power Cooperative)
 - Built in 2007
 - Operating life to 2072
 - 385 MW
 - ~3.3 million tons of CO₂/year
- Wyoming Integrated Test Center (WY-ITC)
 - Test CO₂ capture/CCUS technologies
 - Membrane Technology Research (MTR) Large-scale pilot



Carbon Capture Program at the ITC

Membrane Technology Research (MTR) Large-Scale Capture Pilot



DOE Awards Approximately \$65 Million for Demonstration of Large-Scale Pilot Carbon Capture Technology



DE-FE0031587



Wyoming CarbonSAFE Storage Site



Photo courtesy of Dave Green, Western Fuels



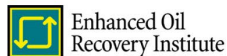
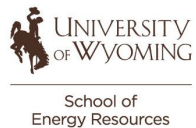
Photo courtesy of Google Earth

Project Participants



ACADEMIC PARTNERS

University of Wyoming
Advanced Resources International
Energy and Environmental Research
Center
Los Alamos National Laboratory



CARBON CAPTURE

Membrane technology and
Research, Inc. (MTR)
Wyoming Integrated Test Center



INDUSTRIAL PARTNERS

Basin Electric Power Cooperative
Schlumberger Carbon Services
Denbury Resources
Oxy Low Carbon Ventures
Carbon GeoCapture
Western Fuels Association
Wyoming Municipal Power Agency



PERMITTING, ENVIRONMENTAL AND REGULATORY EXPERTS

Long Reimer Winegar Beppler, LLP
TriHydro Corporation
Wyoming Energy Authority
Wyoming Department of
Environmental Quality (DEQ)



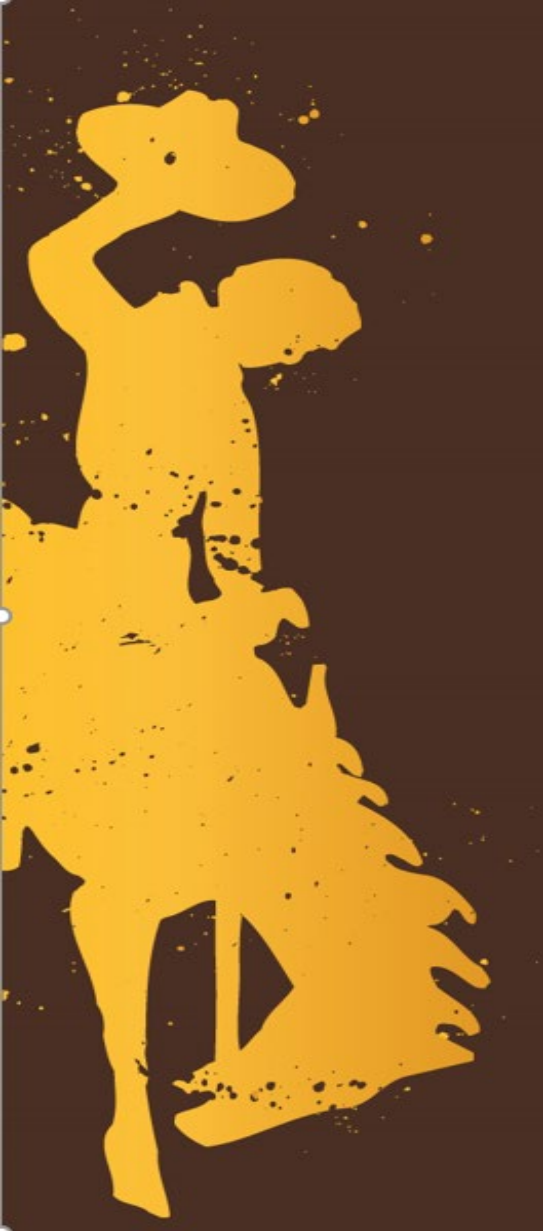
Project Objectives

1. Finalize surface and subsurface characterization activities at DFS
2. Conduct NEPA and environmental analysis
3. Integrate MTR's CO₂ FEED capture assessment
4. Complete Class VI permits to construct for the Wyoming CarbonSAFE storage hub
5. Advance commerciality within the Wyoming CarbonSAFE storage hub

Project funding:

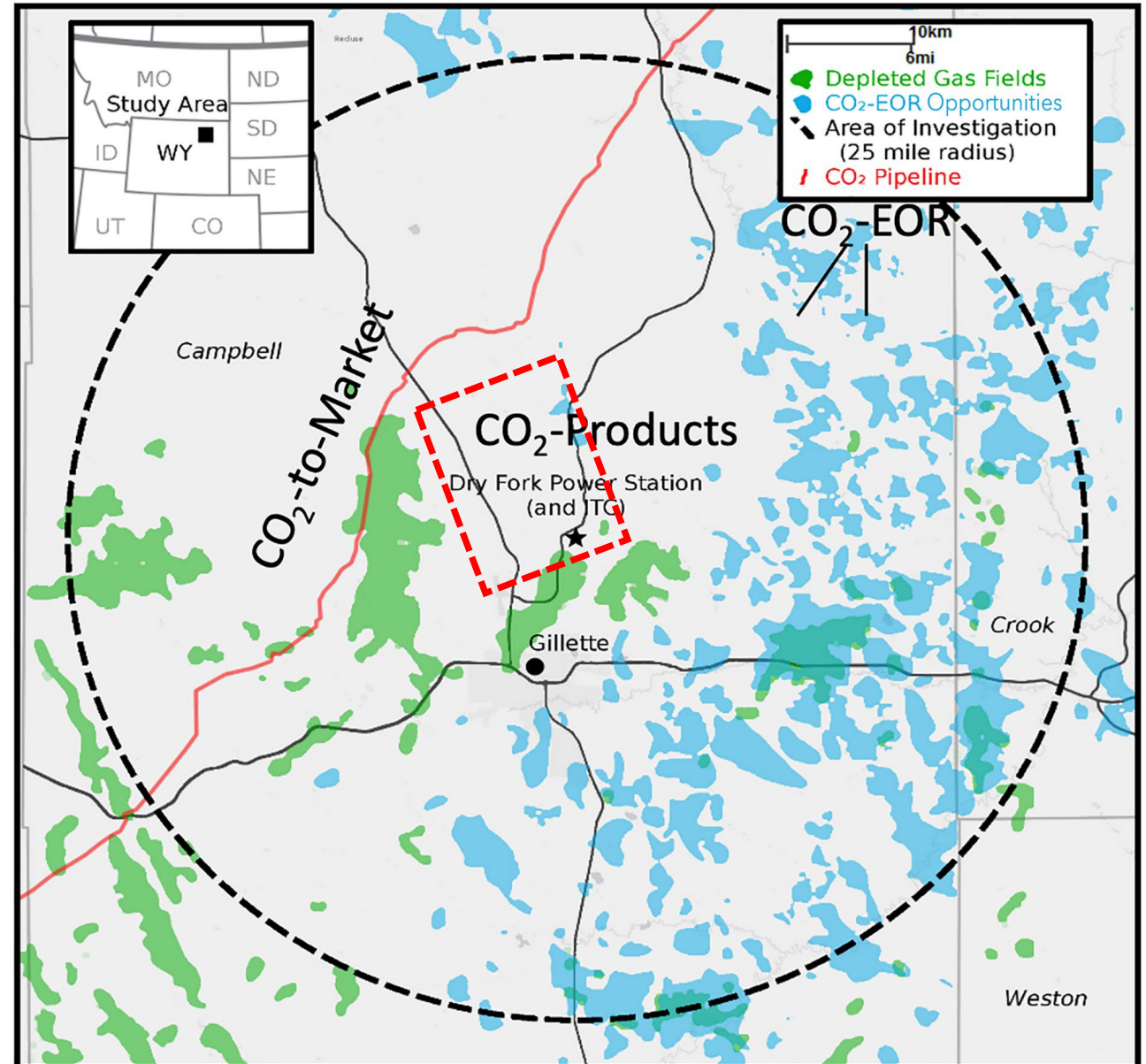
- \$15,526,325 (Federal)
- \$3,941,389 (Cost share)
- \$19,467,714 (Total)

Period of performance: Oct. 2020 to Sept. 2023



Rational for Site Selection

- Modern coal plant with 50+ year life-span
- Located adjacent to:
 - Existing intrastate CO₂ transportation network
 - Multiple utilization industries
 - Carbon to products industry
 - CO₂-EOR for carbon utilization
 - Experienced carbon workforce
 - Multiple CO₂ point sources
 - Transportation infrastructure
- Wyoming has:
 - CO₂ management legislative and gov't framework
 - Class VI primacy
 - Long-term CCUS liability fund
 - Educated and supportive public
 - Geologic capacity



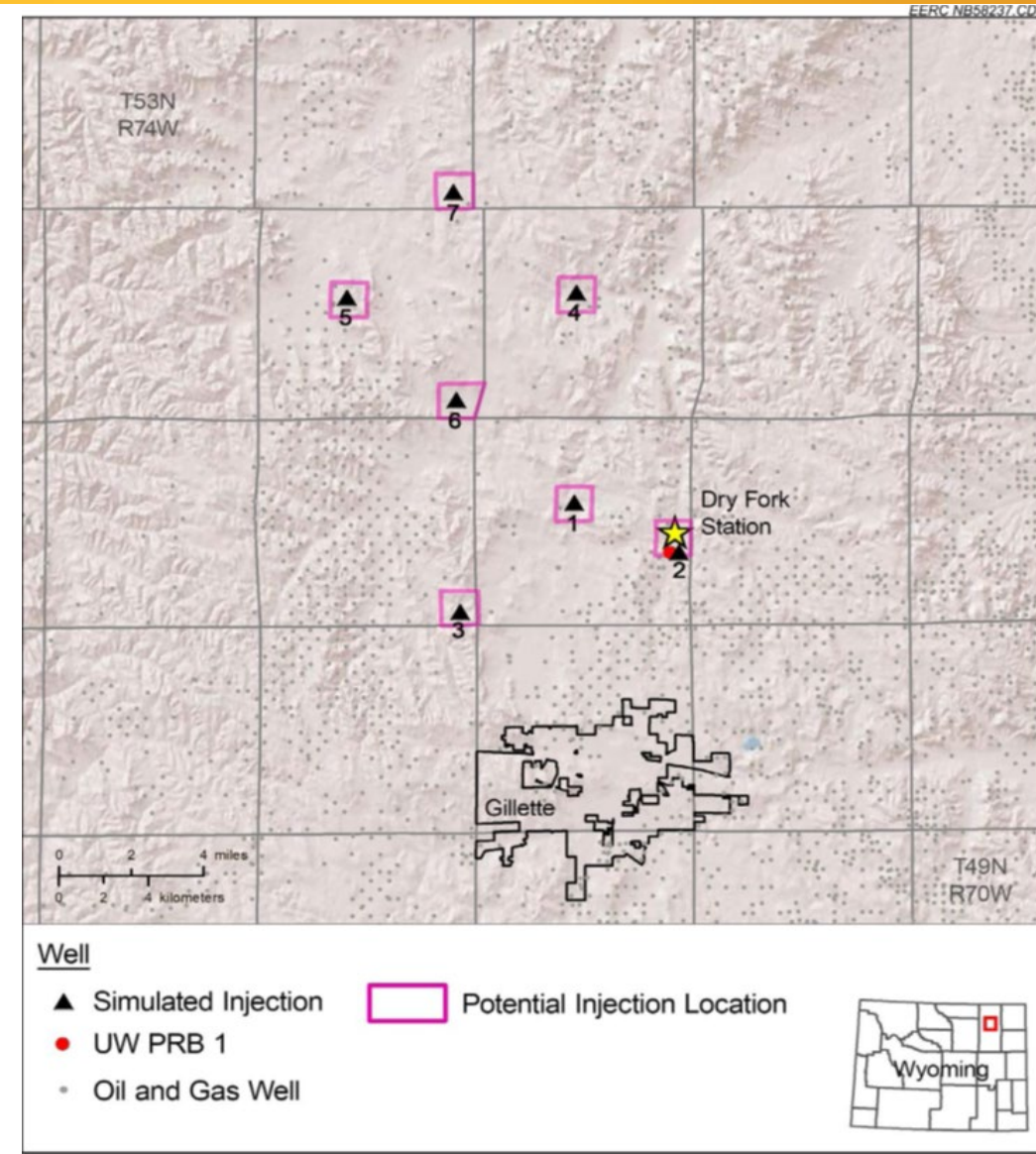
Technical Approach

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Technical Approach

Site Characterization and Commercialization of the Wyoming CarbonSAFE Storage Hub

- Characterize seven sites within the storage hub
- Phases to-date have focused on the DFS site to meet technical objectives
 - 2 wells to optimize stacked storage, reservoir testing, interference tests, subsurface data gap completion
 - Wells completed to Class VI standards
 - Environmental and baseline monitoring
 - Finalize risk assessment and MVA
- Develop and complete Class VI permits for all sites
- Develop business and commercial strategies for the storage hub
- Environmental assessment
- Integrate MTR's capture assessment into commercial plan
- Develop greater regional capacity for additional sources/expansion

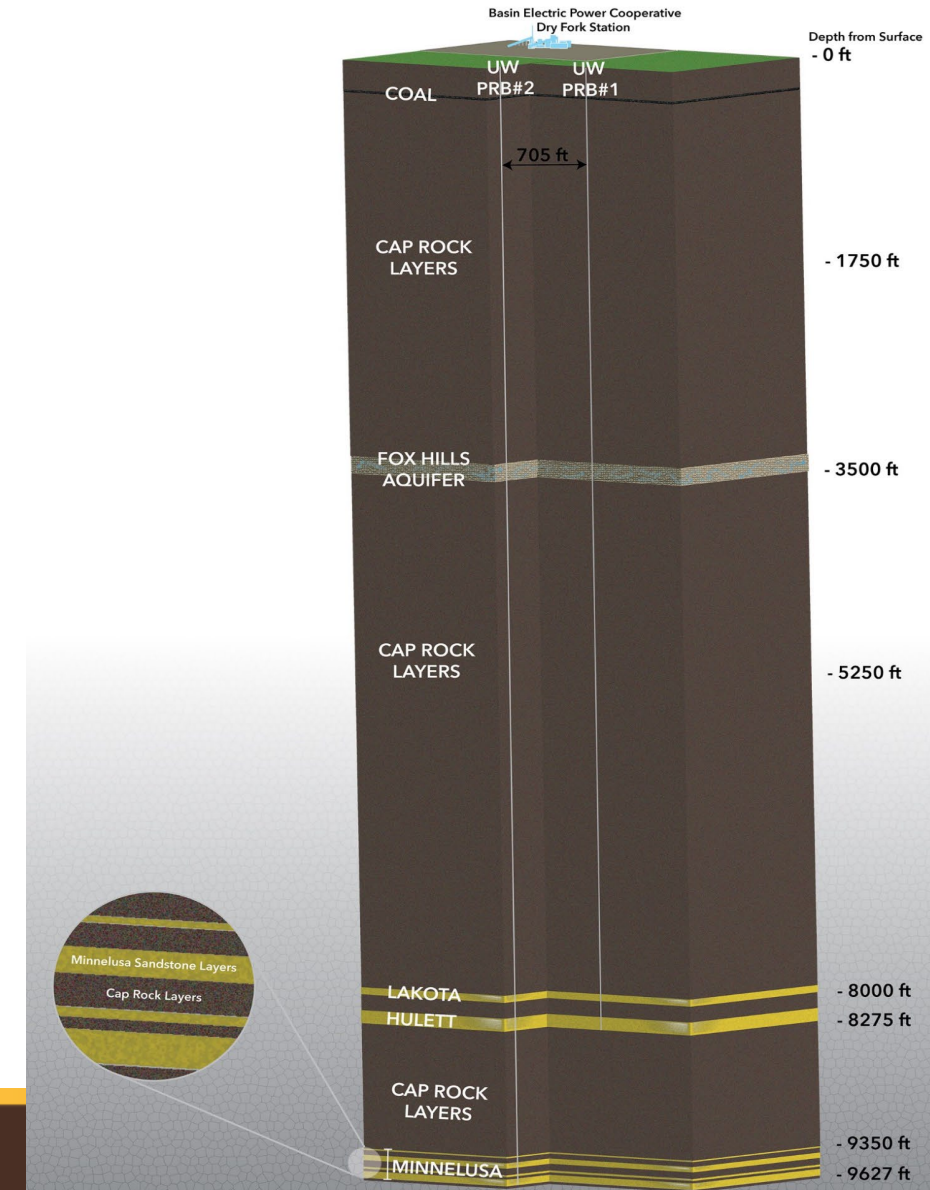


Progress and Current Status

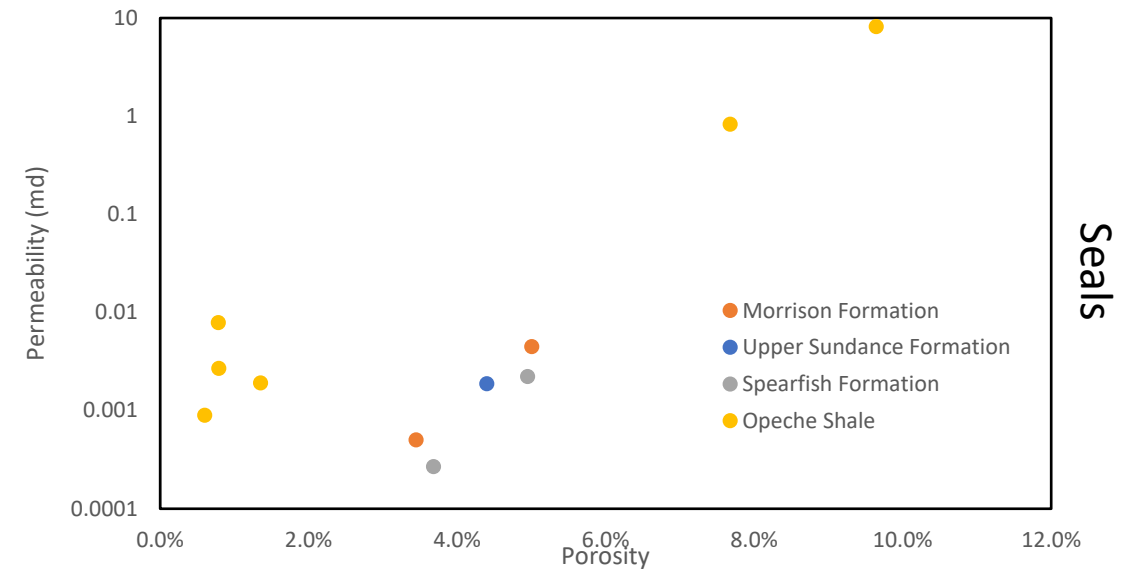
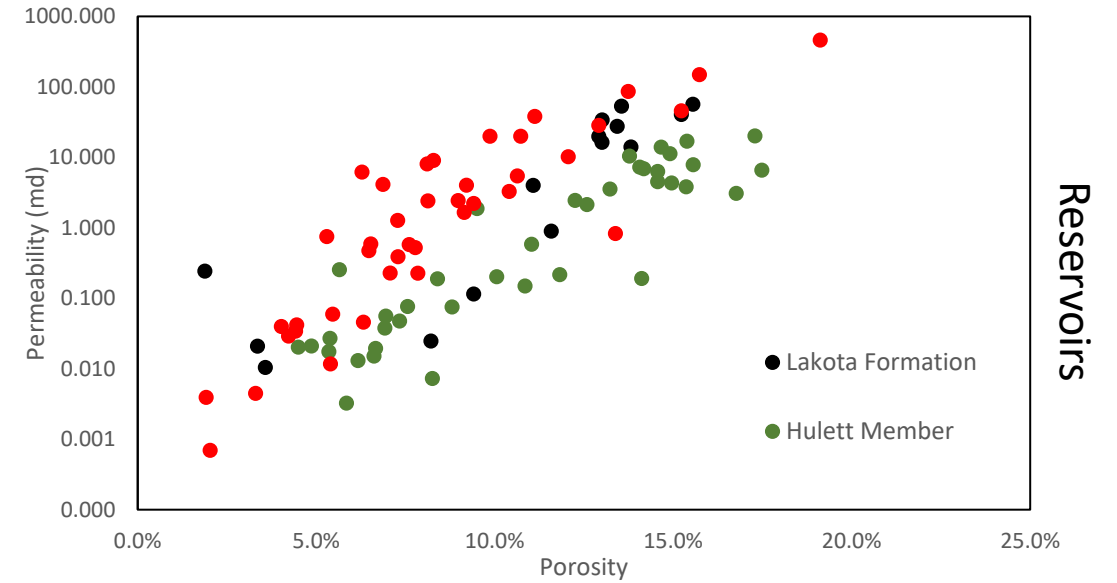
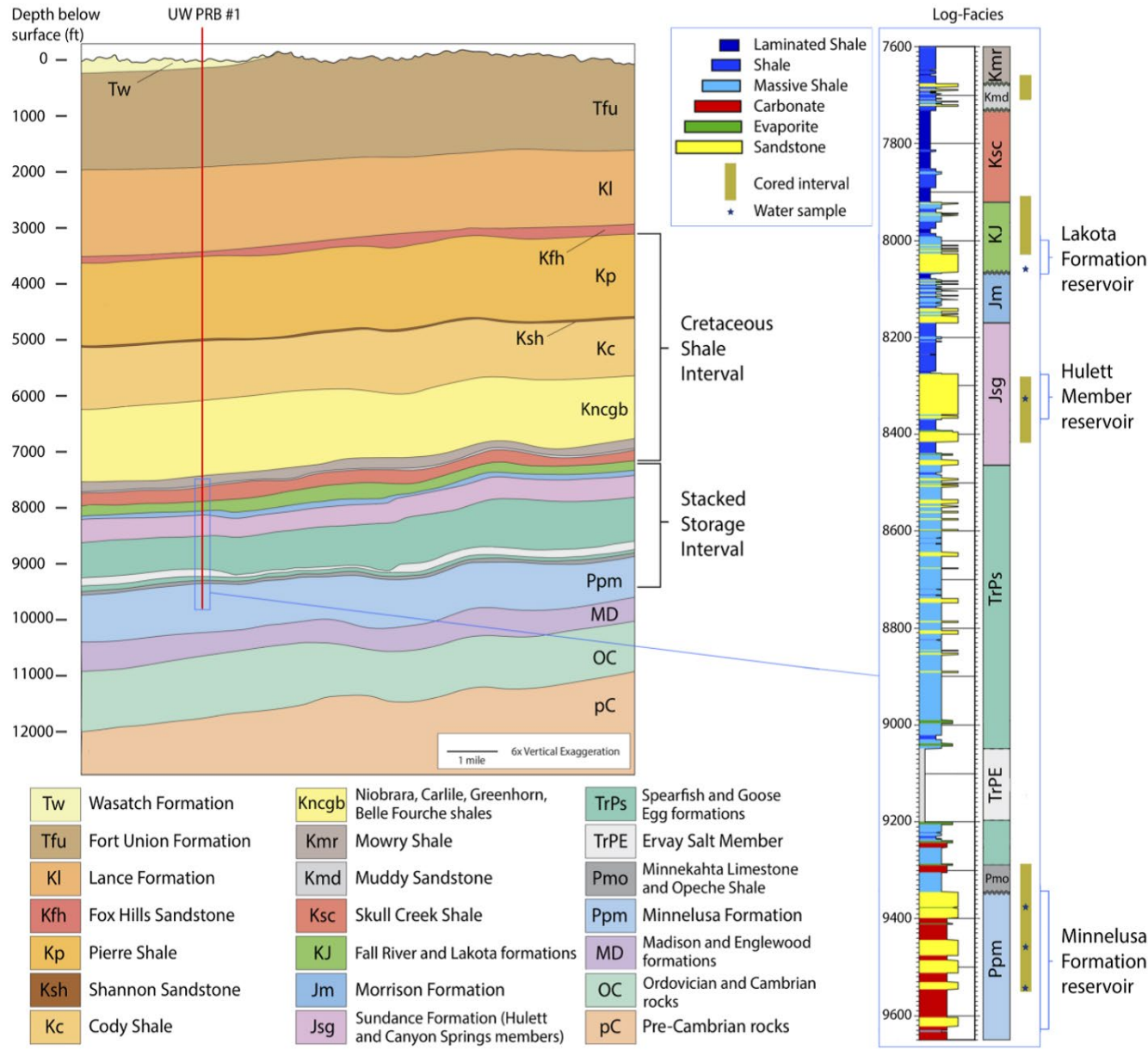
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Progress and Current Status

- Two test wells completed and sampled
 - UW PRB#1 (cased to 8,440')
 - UW PRB#2 (cased to 9,697')
- Completed baseline monitoring assessments
- 3D seismic survey
- Storage hub property models and injection feasibility simulations
- Regulatory assessments
- Economic/business case assessments
- Developing risk and MVA assessments
- Completing permitting
- Building the commercial strategy

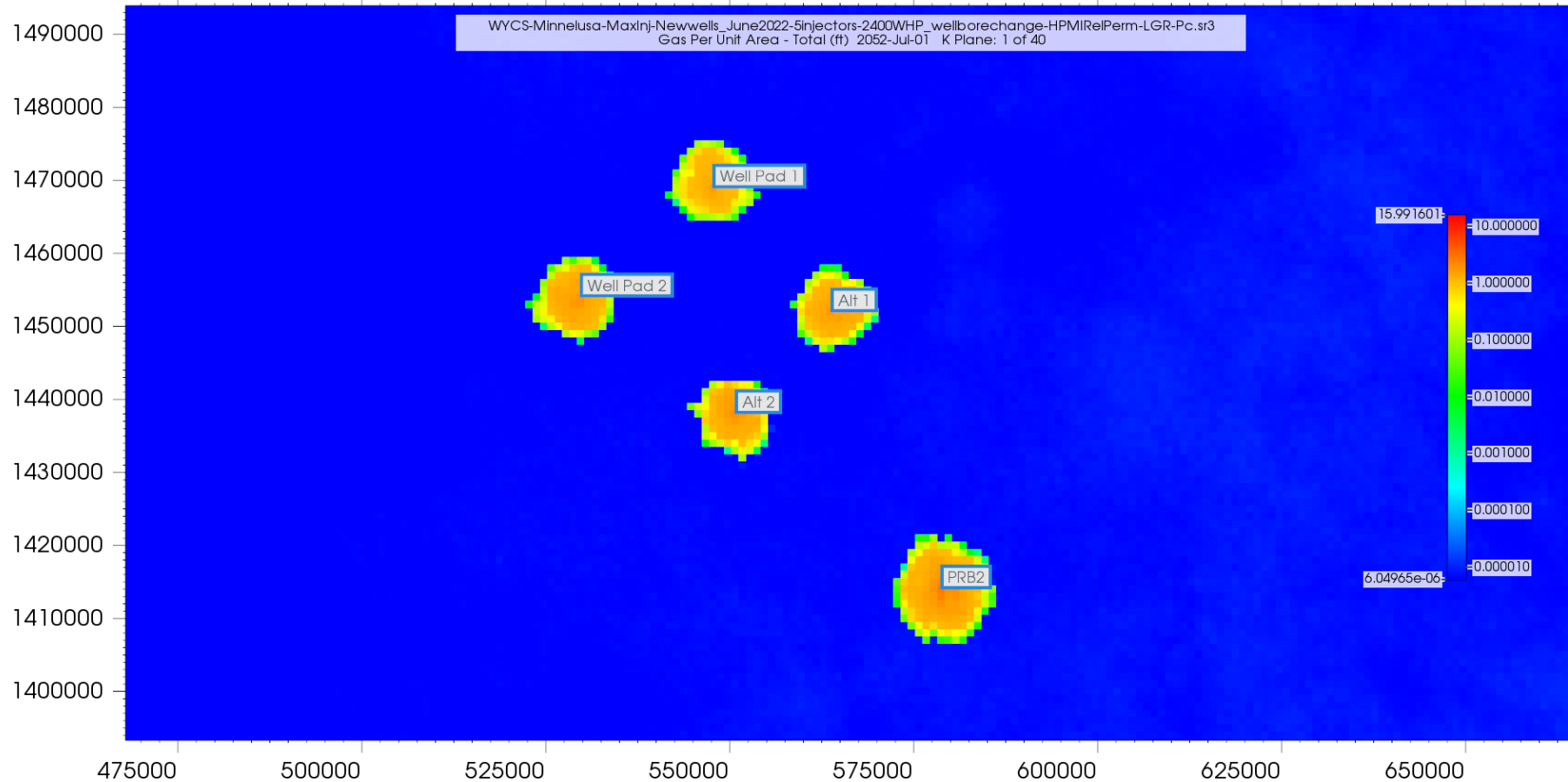


Progress and Current Status



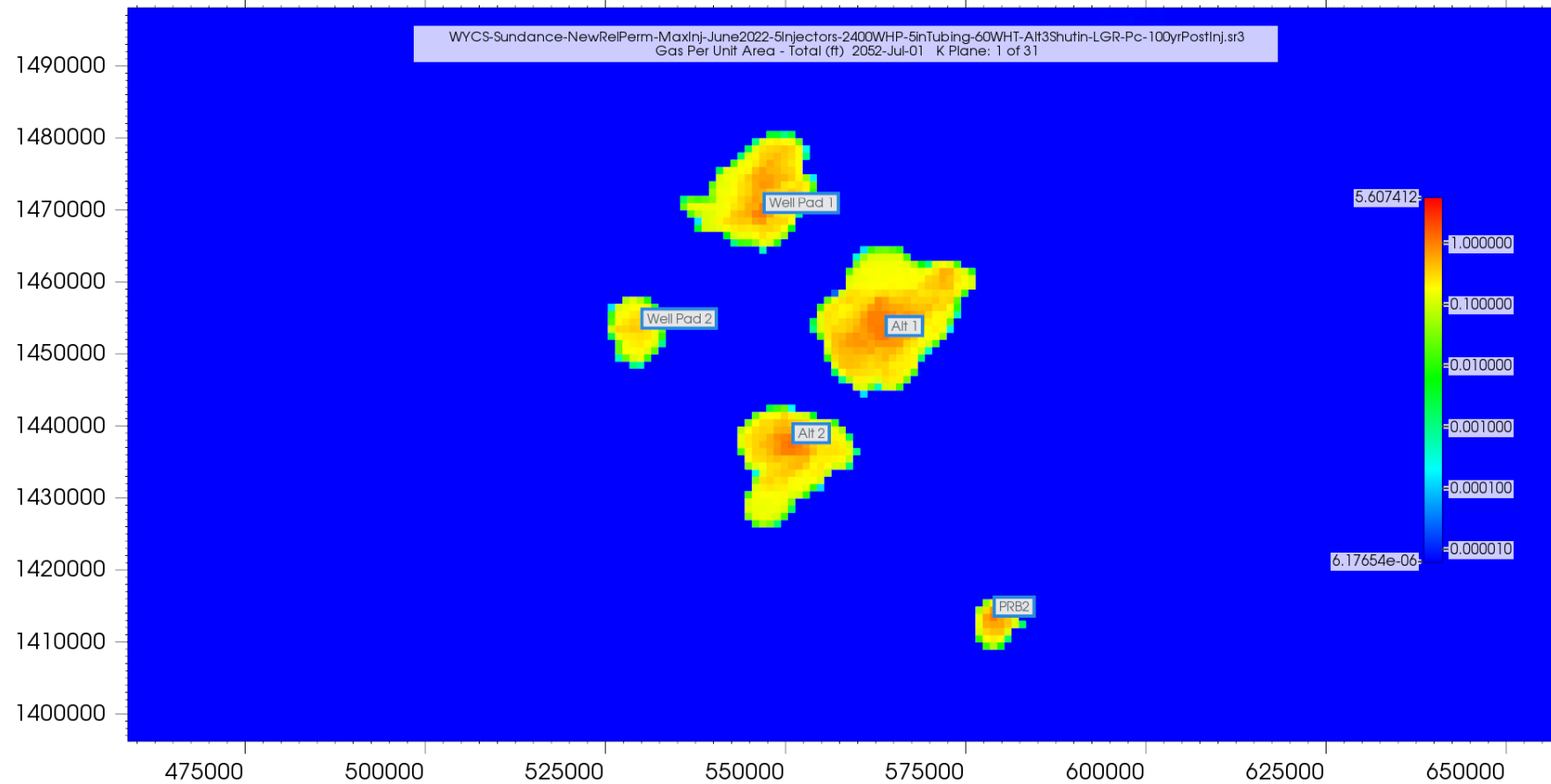
Progress and Current Status

Minnelusa Formation Simulations; 5 Injection wells



Progress and Current Status

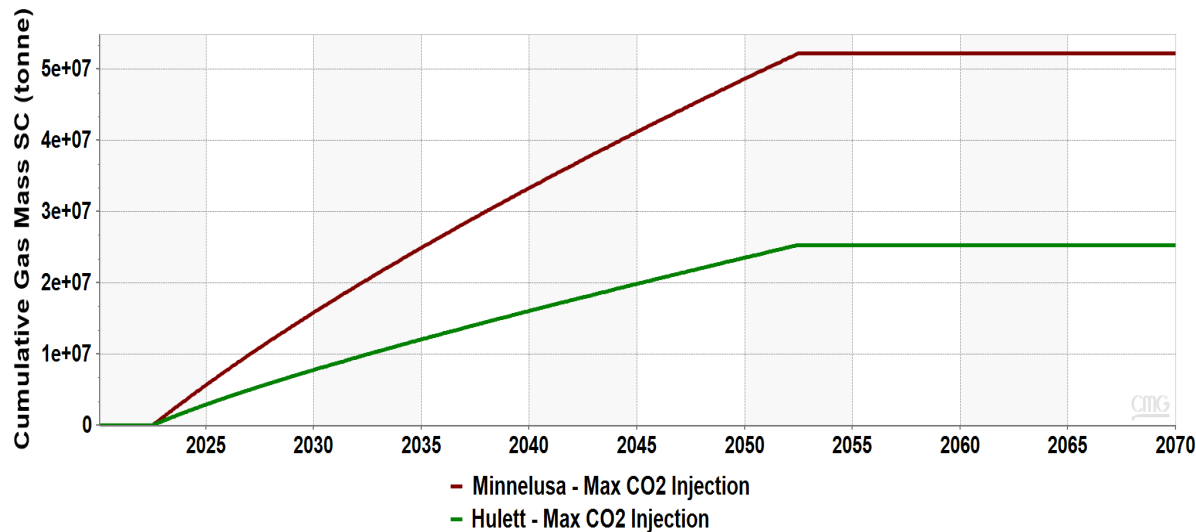
Hulett Sandstone Simulations; 5 Injection wells



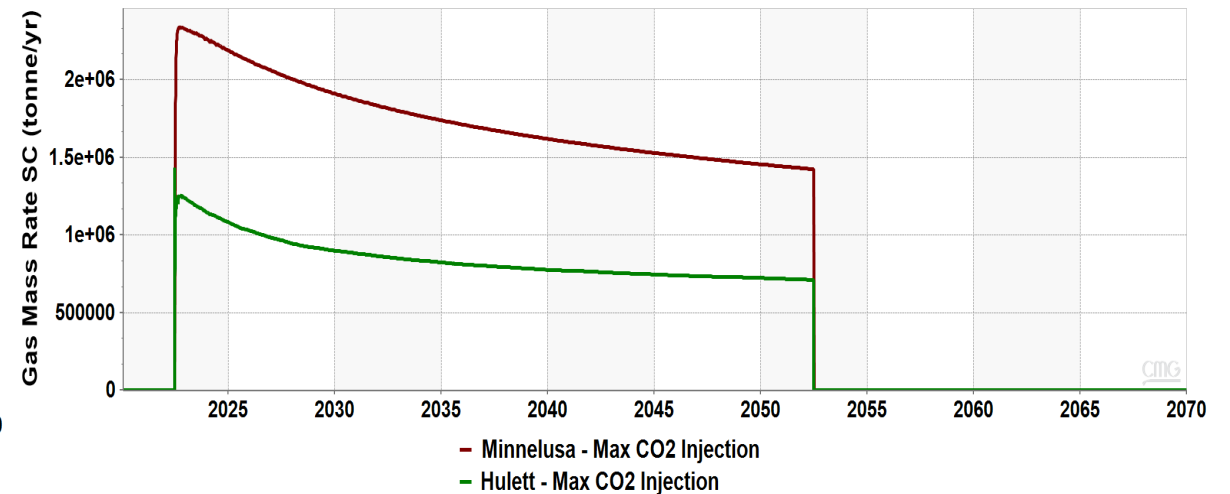
Progress and Current Status

Case	Cumulative Gas (tonnes)	Maximum Injection Rate (tonnes/year)
Minnelusa Fm.	52,259,492	2,342,485
Hulett Ss.	25,338,886	1,262,698

Cumulative Gas Mass



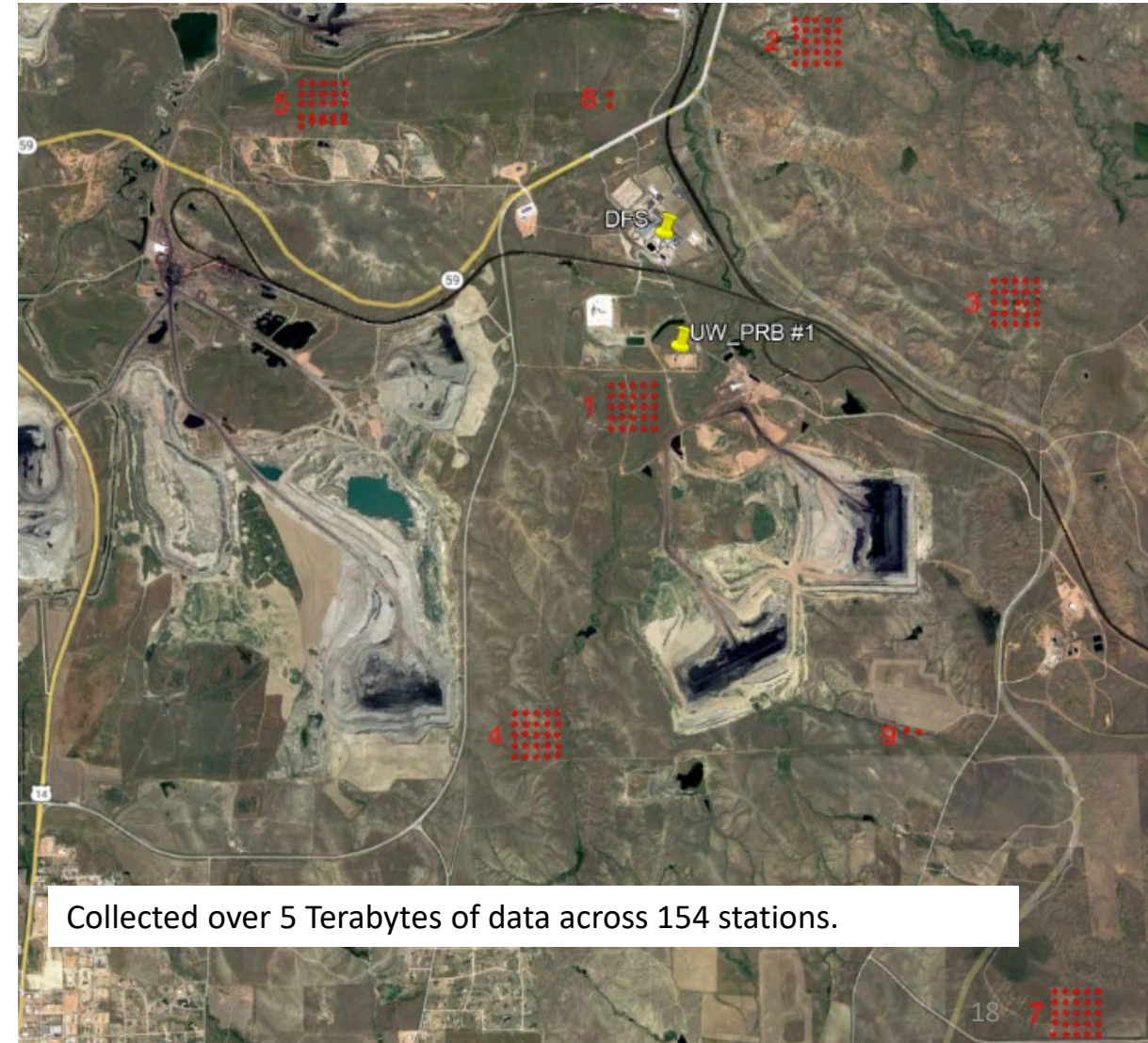
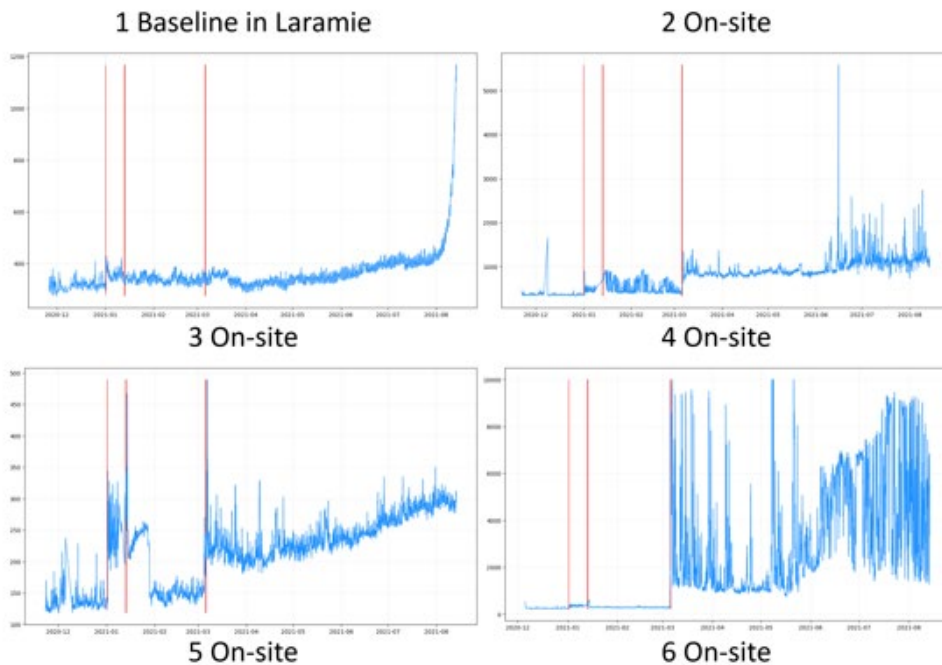
Gas Mass Rate



Progress and Current Status

Environmental and Risk Monitoring

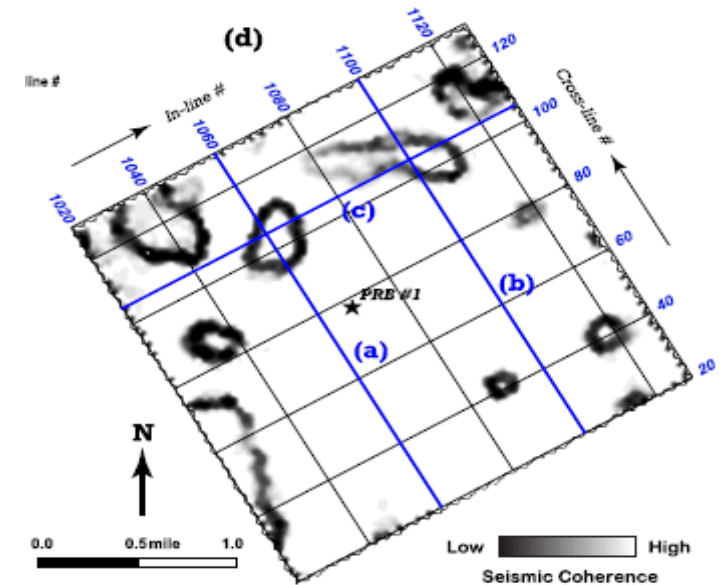
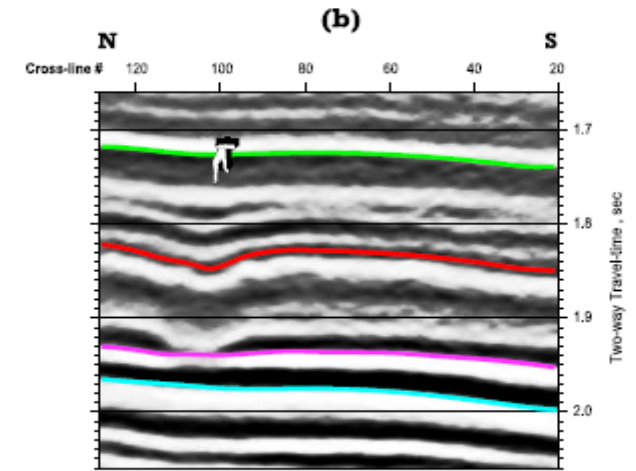
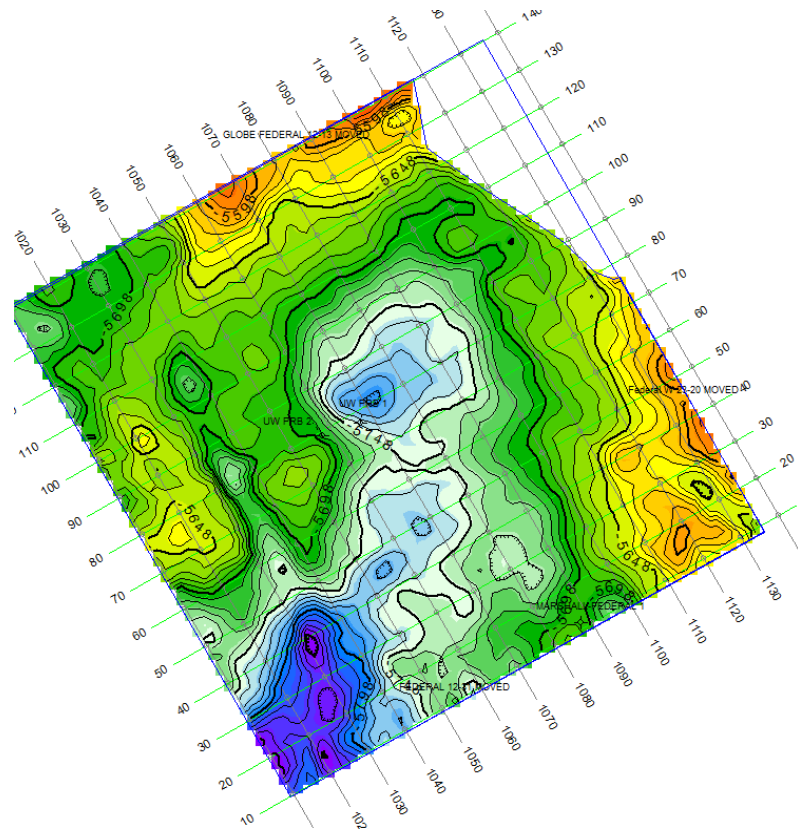
- Three passive seismic technologies
 - Seismicity from natural and industrial sources, drilling and mining operations
- Soil and groundwater monitoring



Progress and Current Status

Risk Assessment

- Regional mine mines did not indicate Laramide faulting
- Seismic identified two geologic structures
 - Paleokarst
 - NE-SW offset and fold
- Legacy HC wells



Progress and Current Status

Applications for Class VI Permits

- Finalizing applications for all Class VI permits to inject and construct (this Fall)
- Lay-out of a full-scale project finalized: (1) pads – e.g., number and locations; (2) injection wells – e.g., number per pad; (3) pipeline(s); and (4) other

Economic Model Update

- Currently updating the project's economic model to include: (1) results of MTR's full-scale FEED study; (2) new laws (e.g., amendments to section 45Q and Wyoming's new long-term stewardship law); and (3) latest project technical results and assumptions

Commercialization Working Groups

- Four topic-specific commercialization working groups are meeting: (1) project finance/economics; (2) CO₂-EOR; (3) long-term stewardship; and (4) legal

Progress and Current Status

Policy Analyses

- 45Q Amendments
- BLM Policy for CCS on Federal Lands
- Wyoming's New Long-Term Stewardship Bill
- Peer-Reviewed Paper: "Policy-Driven Potential for Deploying Carbon Capture and Sequestration in a Fossil-Rich Power Sector": <https://pubs.acs.org/doi/full/10.1021/acs.est.1c08837> (July 2, 2022)

NEPA

- The final Environmental Information Volume (EIV) was submitted on October 12, 2021. The EIV concluded: "Project information available at this time does not indicate that the Project is likely to have significant impacts on any of the resources addressed herein" (p. 1-1)

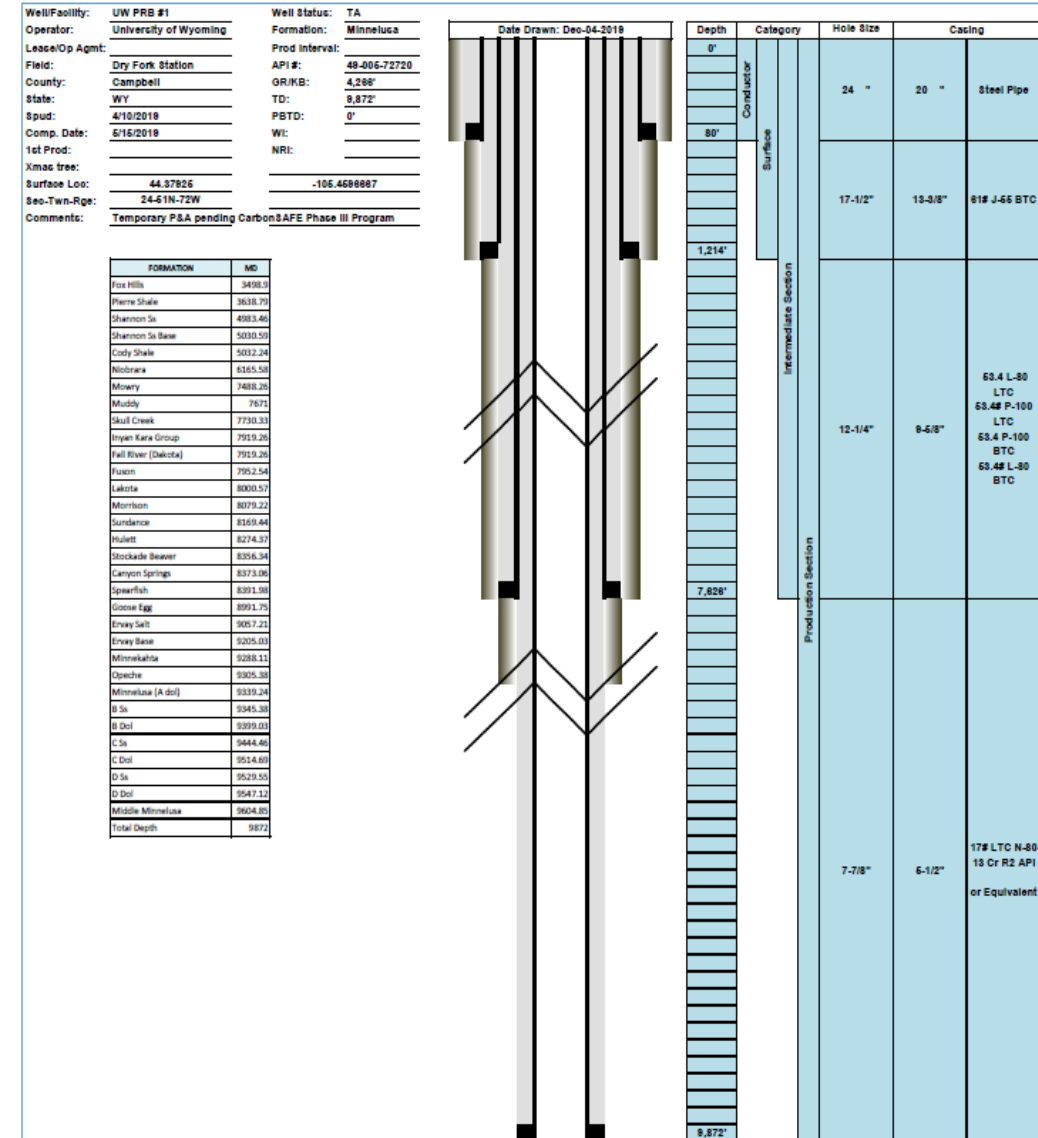
Public Outreach

- SER's 3-D Visualization Center is working on a project visualization tool
- Developing CCUS classes and educational tools, and continuing to engage local/regional media outlets

Progress and Current Status

Synergy

- Regional initiatives through PCOR
- Integration with Membrane Technology Resources
- Collaborating with the ITC
- Supporting Research Experience in Carbon Storage
- Providing case examples for the DEQ permitting team
 - Also industry partners on their commercial endeavors
- Helping to frame the Wyoming Energy Authority's strategy for the State
- Collaboration with other CSAFE projects
- Providing a methodology to develop a carbon storage hub
- Lessons and data being used to develop other energy hubs (hydrogen and DAC)
- Lessons and data being used to develop other commercial projects
- Supporting and guiding Wyoming's Net Zero Carbon Strategy



Summary and Next Steps

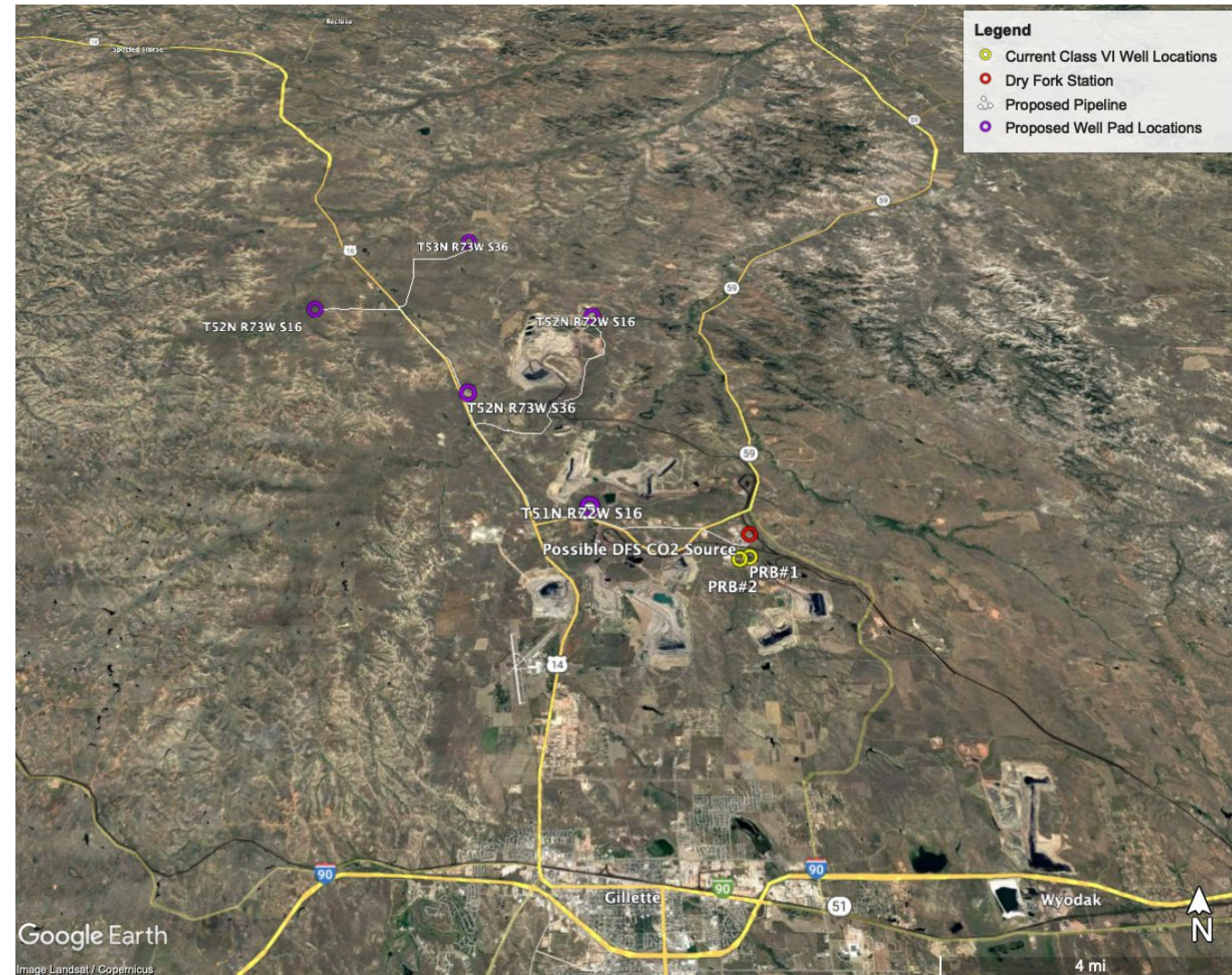
Summary:

- Storage site characterization nearly complete
- Environmental/baseline monitoring completed
- Model agreements developed and submitted
- NEPA
- Outreach
- Economic model

Future work:

- Update and integration of commercialization plan for the Wyoming CarbonSAFE Storage Hub
 - Finalize permitting
 - Develop and build the hub-scale monitoring network
 - Develop and build four additional injection sites within the hub
 - Develop and build transportation network for the storage hub
 - SMRS

The Wyoming CarbonSAFE Storage Hub



Schedule/milestones/success criteria

Key milestones

Milestone Title & Description	Completion Date
Finalize initial environmental assessment	3/30/2021
Initiate drilling of UW PRB#2	9/30/2021
Update models with seismic and field data	1/1/2022
Initiate Class VI applications	11/1/2020
Submittal of Class VI permits	9/30/2022
Complete risk assessment	1/31/2023
Public Outreach meeting	9/1/2021
Identification of potential business partners	1/31/2023

Success criteria

EIV identifies site(s) issues
CO ₂ capture study is not completed
Submitting and receiving applications to initiate drilling
Obtaining access agreements
Drilling UW PRB#2
Complete subsurface field testing and monitoring

Project risks and mitigation strategies

Perceived Risk	Mitigation/Response Strategy
Financial Risks:	
Drilling expenses	Rates are subject to the market price of oil. If rates increase, the co-PIs will look for ways to absorb costs in other areas of the project.
Cost/Schedule Risks:	
Project timeline	The Project timeline was developed based on the experienced gained from previous projects of this scale and will communicate regularly with the DOE program Manager.
Technical/Scope Risks:	
NEPA assessments	UW will select an environmental consultant with a proven record of accomplishment of EIVs.
Drilling and field operations	Challenges will be addressed through the team's prior experience with drilling operations and the selection of experienced contractors and commercial technologies.
Data collection	The team has extensive experience performing fieldwork in the PRB and has successfully collected the necessary data
Subsurface modeling	CEGR, EERC and ARI have extensive experience with the industry-standard software packages that will be used
Class VI well permitting	WYDEQ has received Class VI primacy and the Project team has collaborated closely with WYDEQ on permitting strategies
CO ₂ source commitment	As demonstrated by the CO ₂ source commitment letters, BEPC (source) and MTR (capture) can provide the CO ₂ for successful implementation of future phases.
Management, Planning and Oversight Risks:	
Project Management	Risks are negligible due to the team's collective experience in projects of this type.
ES&H Risks:	
Operations	All physical activities, including drilling, will be overseen in compliance with applicable laws.
External Factor Risks:	
Site access	The drilling site is on land owned by partner BEPC, which mitigates these concerns.
Pore space ownership	Risk will be addressed by WY law, which defines pore space ownership; minimization of project impacts; and project siting to focus impacts on land owned by team members. Risks are at medium due to the first-of-its-kind program.
Public acceptance	The Project team will continue to implement the outreach strategy deployed during Phases I & II.
Resource availability	Resource availability risks include access to a drilling site, equipment and skilled labor. These are negligible as BEPC will construct the drilling site and the PRB has a skilled workforce.

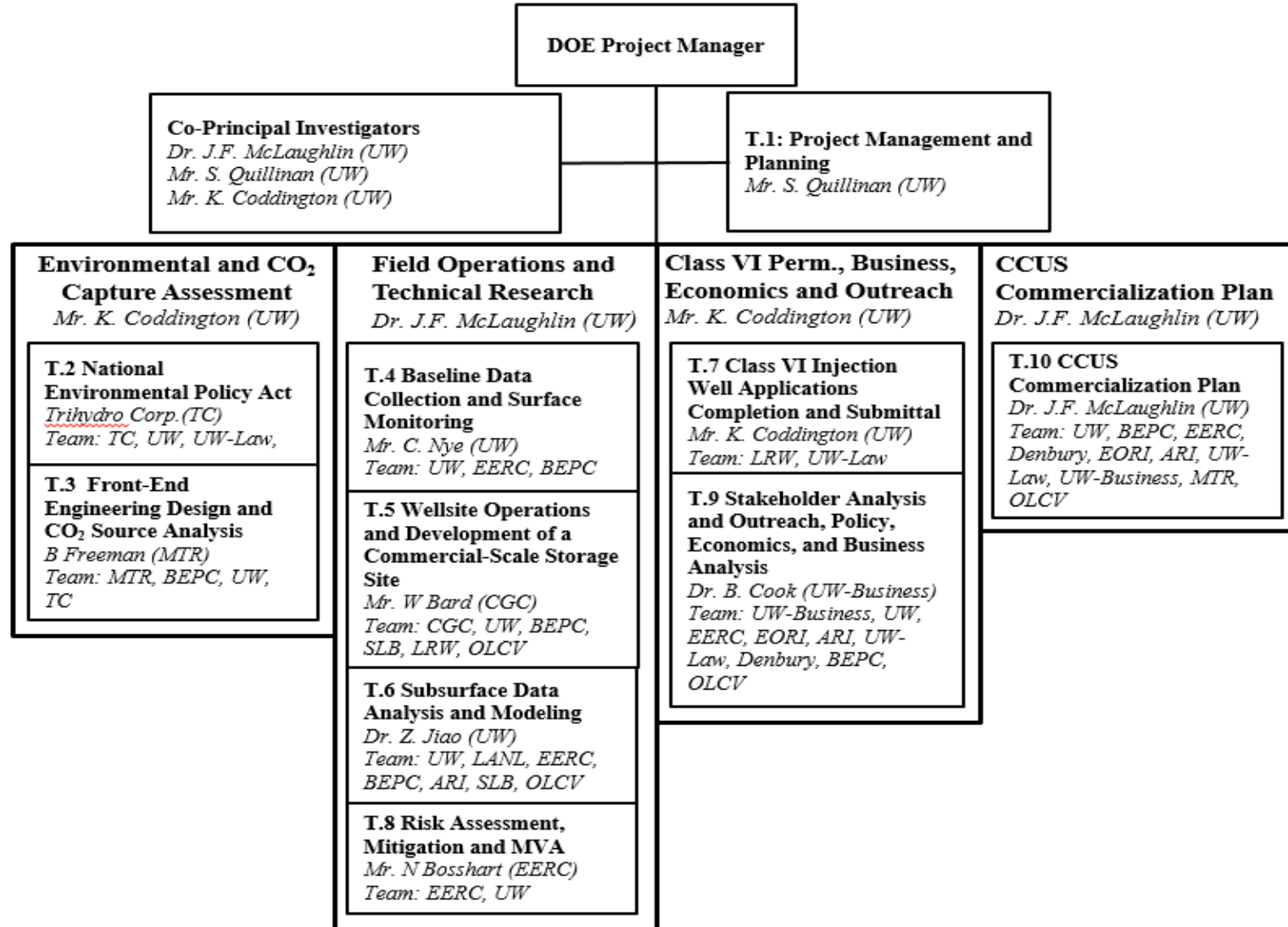
Questions?



Appendix

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Organization Chart



Gantt Chart

	Year 1				Year 2				Year 3			
	Budget Period I								Budget Period II			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1.0 Project Management and Planning												
1.1 Project Management Plan	M.1											
1.2 Data Management Plan												
1.3 Technology Maturation Plan												
2.0 National Environmental Policy Act												
2.1 Preparation and Submission for NEPA for CO2 Capture												
2.2 Preparation of EIV	M.2											
2.3 Preparation and Submission of NEPA for CO2 storage												
3.0 FEED and CO2 Capture Analysis												
3.1 Summary of the FEED CO2 capture												
3.2 Assessment of DE-FOA-0002058												
4.0 Baseline Data Collection Monitoring												
4.1 Establish microseismicity baselines												
4.2 Establish monitoring baselines			M.3									

5.0 Wellsite Operations and Development

5.1 Permitting and approvals

5.2 Site Preparation

5.3 Drilling Operations

5.4 Downhole sampling and logging

5.5 Subsurface field testing and monitoring

5.6 Site closure

6.0 Subsurface Data Analysis and Modeling

6.1 Subsurface data analysis

6.2 Process and interpret seismic 3D survey

6.3 Complete models of geological structure

6.4 Update numerical injection simulations

6.5 Geomechanical modeling

6.6 Machine Learning

6.7 NRAP risk assessment of legacy wellbores

7.0 Class VI Injection Well Applications

7.1 Permitting technical data and plans

7.2 Other permit data and filing of applications

7.3 Technical review of engineering standards

8.0 Risk Assessment, Mitigation and MVA

8.1 Risk Assessment and Mitigation

8.2 Finalize an MVA Plan

9.0 Stakeholder Analysis and Outreach, Policy, Economics, and Business Analysis

9.1 Stakeholder Analysis and Public Outreach

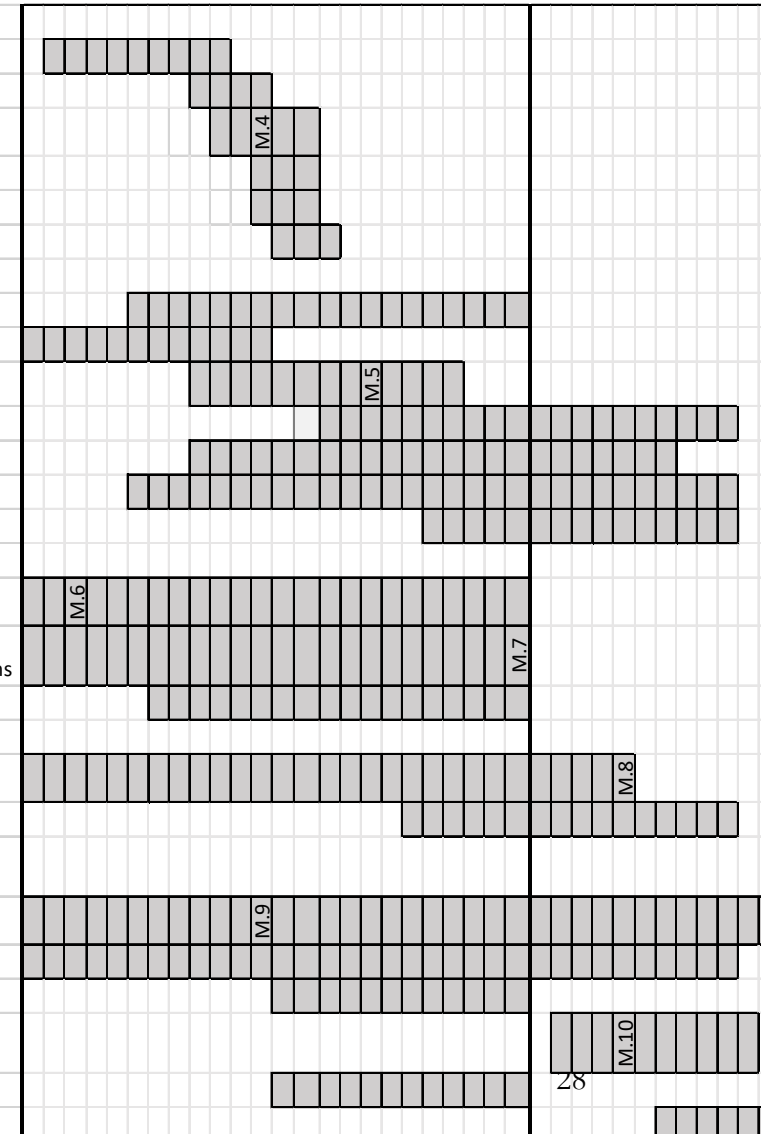
9.2 Regulatory and policy assessment

9.3 Finalize commercial business plan

9.4 Implementation of the business plan

9.5 Preparation of a staged build-out plan

10 CCUS Commercialization Plan



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