San Juan Basin CarbonSAFE Phase III: Ensuring Safe Subsurface Storage of CO_2 in Saline Reservoirs

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Carbon Capture Front End Engineering Design Studies and CarbonSafe

2020 Integrated Review Webinar

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Presentation Outline

- Project overview
- Project objectives
- Overview of San Juan Generating Station
- Geology of San Juan Basin
- Technical Approach
- Accomplishments
- Synergy Opportunities
- Summary

Program Overview

- Funding Profile
- Overall Project Performance Dates

October 2020 – September 2023

- This project did not go through Phase I and Phase II

	BP 1		BP 2		Total	
	DOE Funds	Cost Share	DOE Funds	Cost Share	DOE Funds	Cost Share
NMIMT	12,372,219	578,070	1,064,448	52,268	13,436,668	630,338
University of Utah	502,730	125,683	247,270	61,817	750,000	187,500
University of New Mexico	134,117	-	49,423	-	183,540	-
University of Wyoming	200,000	-	-	-	200,000	-
Wheaton College	30,322	-	15,847	-	46,170	-
Los Alamos National Laboratory	1,333,334	-	466,774	-	1,800,107	-
Sandia National Laboratories	502,539	-	233,256	-	735,794	-
Enchant Energy Corporation		675,988	-	337,994	-	1,013,982
Schlumberger		2,388,999	-	131,001	-	2,520,000
Total ($)	15,075,260	3,768,739	2,077,018	583,080	17,152,278	4,351,820
Total Cost Share %		20.00		21.92		20.24

Project Participants

- New Mexico Institute of Mining and Technology (NMT-PRRC)
- New Mexico Bureau of Geology (NMBG)
- University of Utah (UU),
- Enchant Energy LLC,
- Los Alamos National Laboratory (LANL),
- Sandia National Laboratories (SNL),
- University of New Mexico (UNM),
- University of Wyoming (UW),
- Wheaton College,
- Hilcorp Energy,
- Robert L. Bayless, Producer LLC,
- Schlumberger
- Geolex Inc.
- Contractors (Path Three Marketing, Sargent & Lundy, Projeo)

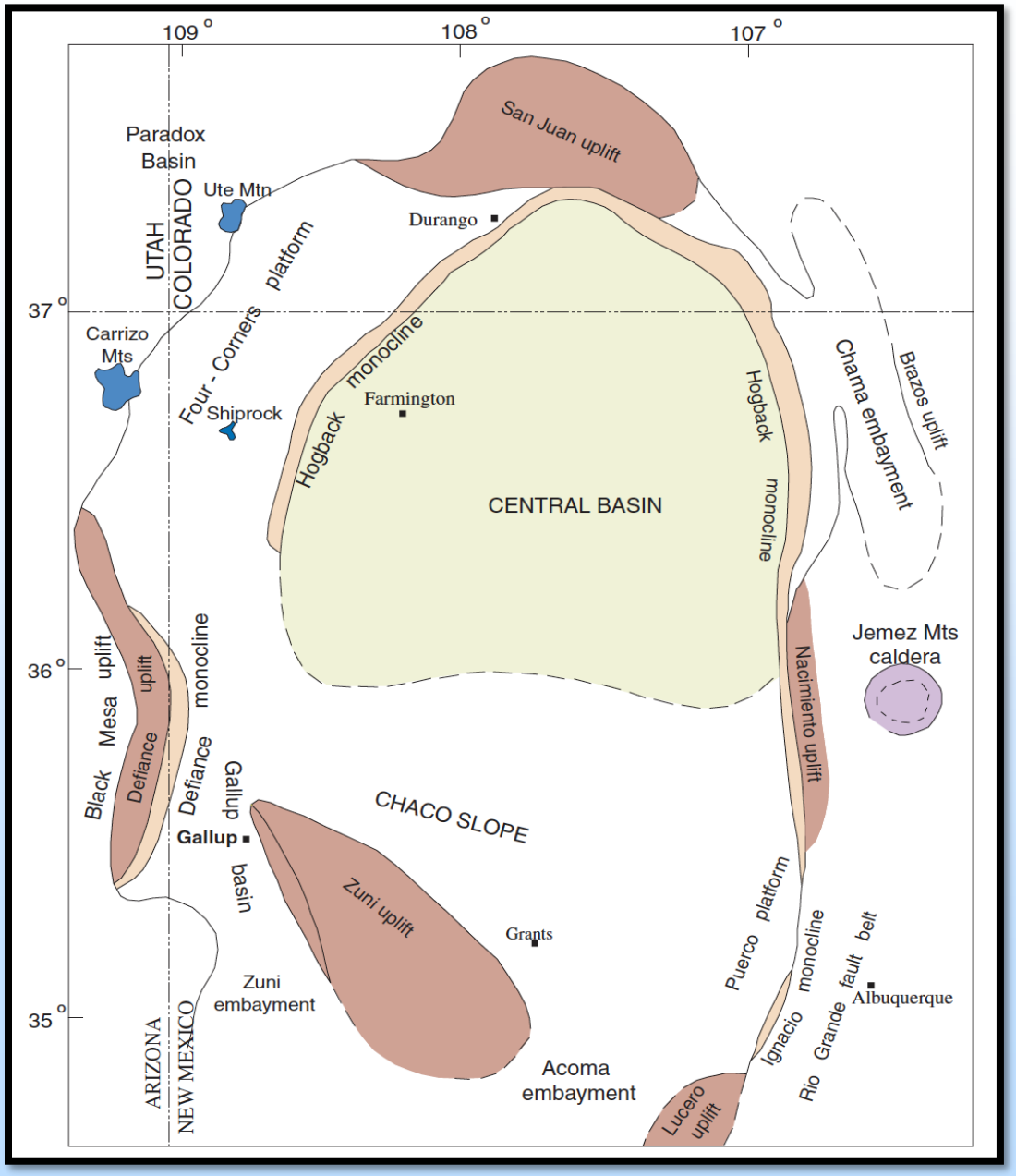
Project Objectives

- Perform a comprehensive site characterization of a storage complex located in northwest New Mexico to accelerate the deployment of CCS technology at the San Juan Generating Station (SJGS)
- The data and analysis performed will be used to prepare, submit and obtain UIC Class VI permit from the Environmental Protection Agency (EPA).
- Techno-economic assessment of entire SJGS-CCS project to reduce emissions by more than 90%.
- Public awareness of CCS technology and its benefits
- Collaborate with regional partnerships and regional initiative projects to accelerate CCS technology deployment in the region

San Juan Generating Station

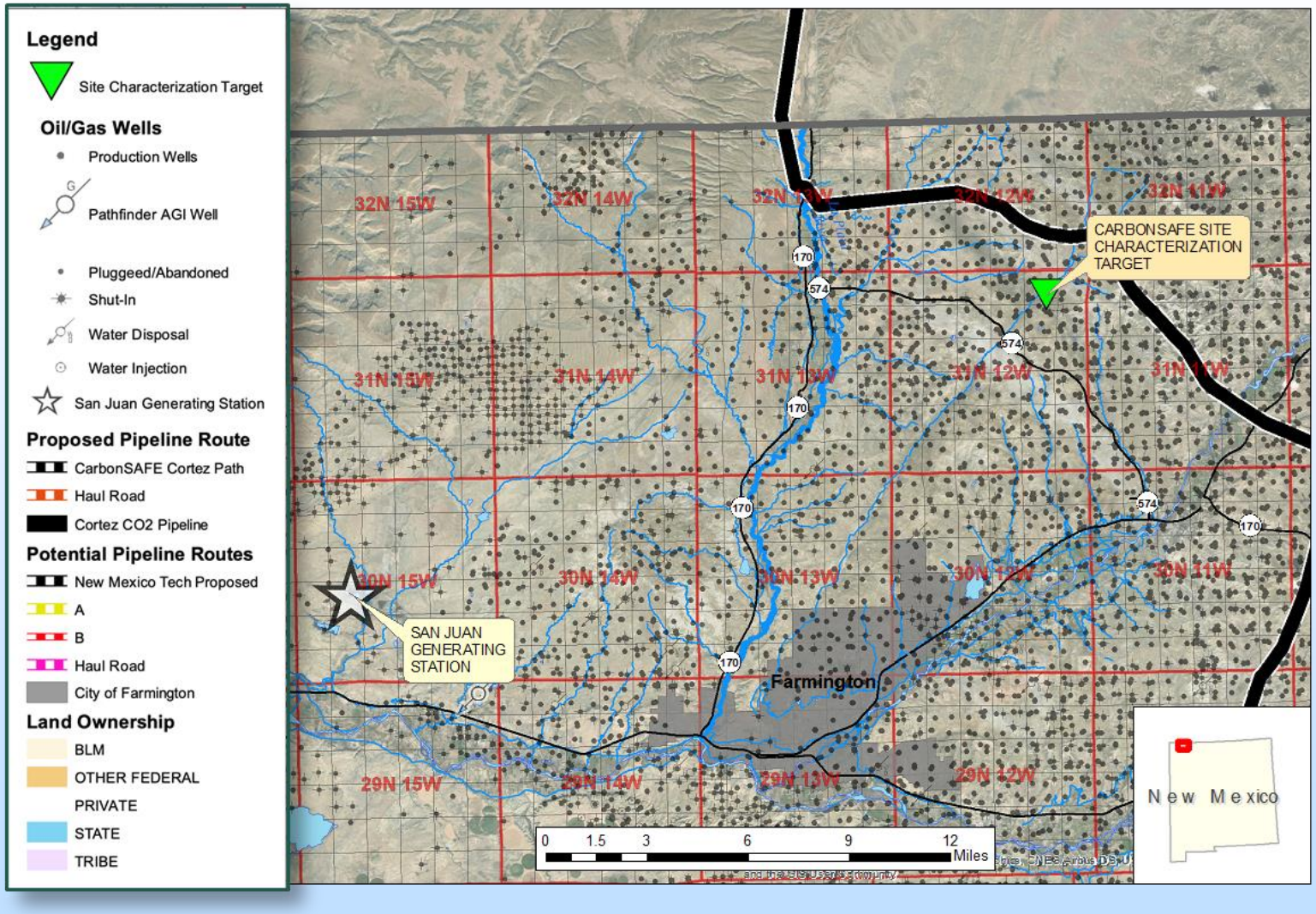
- 847 MW coal-fired electricity generation station
- Built in 1970s, expanded in the 1980s
- Enchant Energy, a new major stakeholder in 2020, completed a successful pre-feasibility study to evaluate technical feasibility and cost of implementing CCUS technology at the plant.
- CO_2 captured will be 6 million tonnes per year
- This project is the potential gateway on large-scale CCS in SJB

San Juan Basin Geology



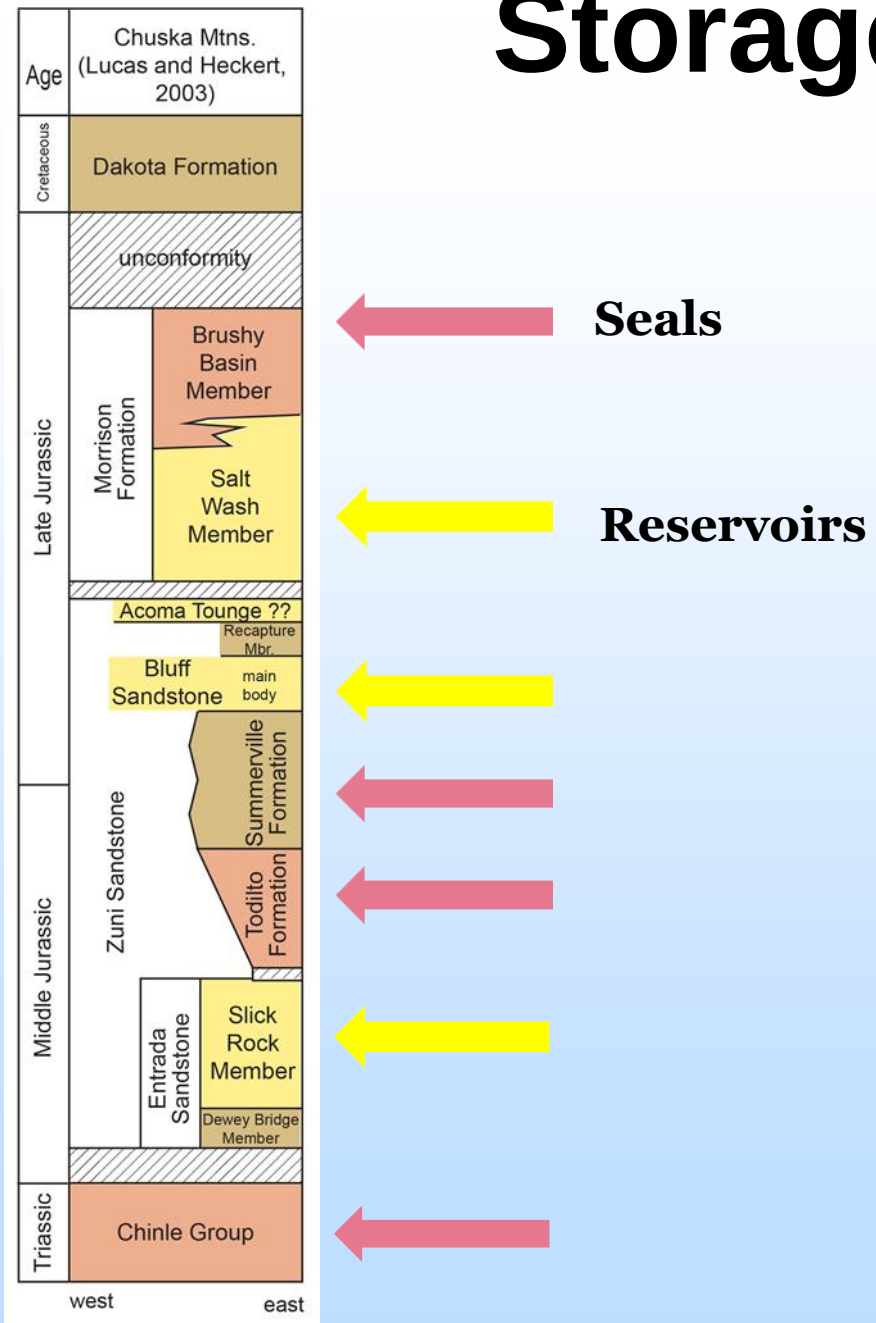
- Located in the northwest corner of New Mexico and southwest corner of Colorado
- Asymmetric basin: deepest part is the Central Basin
- Surrounded by numerous uplifts
- The Hogback monocline circles approximately half of the basin
  - Cretaceous
  - or Laramide-age deformation
  - Crustal shortening forming low-angle thrust fault

San Juan Basin Geology



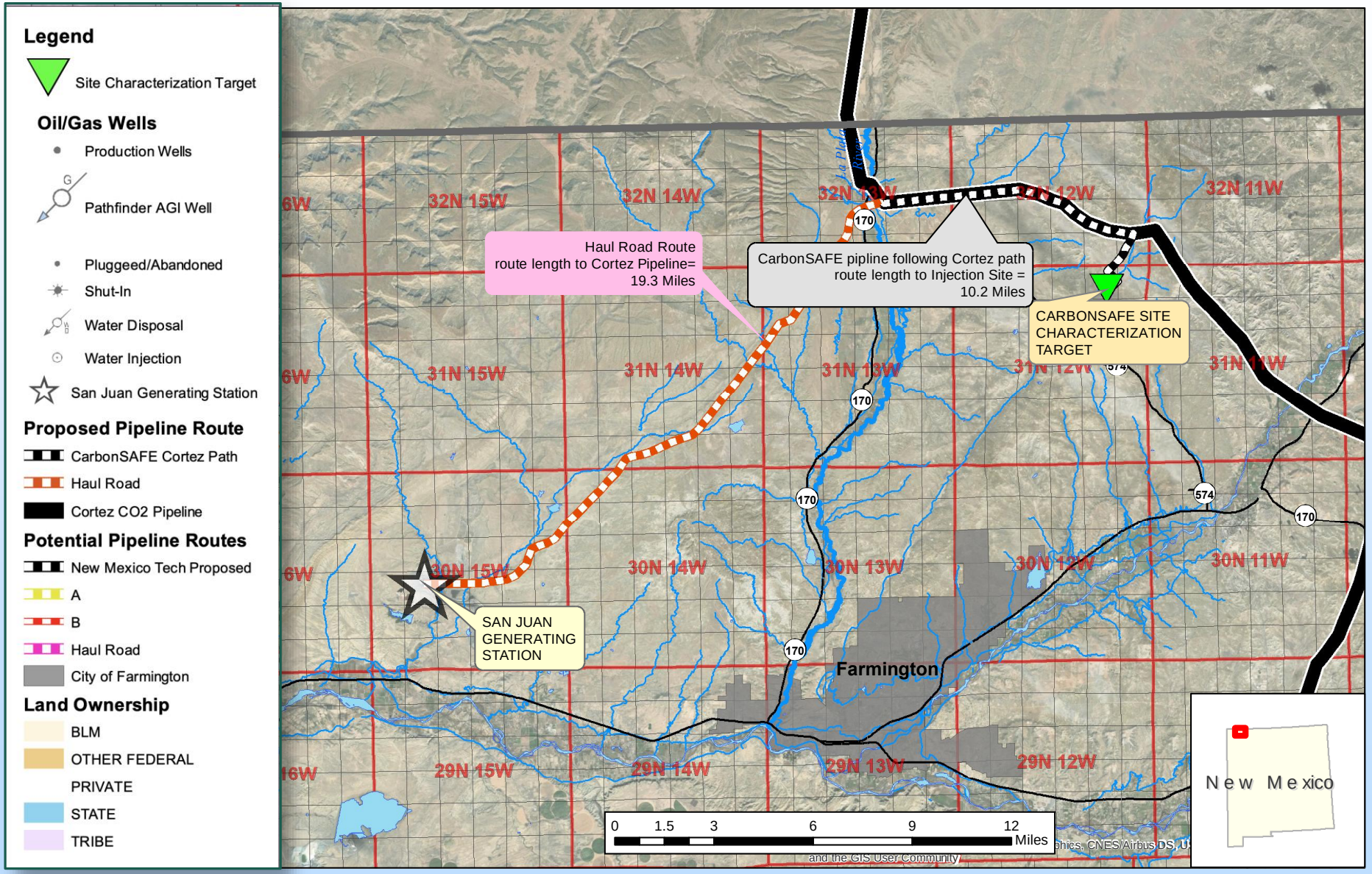
- Extensive oil and gas exploration and production
  - Over 2,500 wells within 10 miles of proposed site characterization target
  - Over 31,000 wells in SJB
- Cumulative production (2009)
  - 42.6 trillion cubic feet of gas
  - 381 million barrels of oil

Storage Complex @ SJ Basin



- Multiple sandstone zones with good porosity and permeability
- No production in the area within the lower units
- Jurassic era formation within the storage complex
- Sandstones are interbedded with siltstones and shales as well as overlying shales and carbonates that can act as seals
- Morrison Formation has numerous high porosity zones encased in siltstones and shale

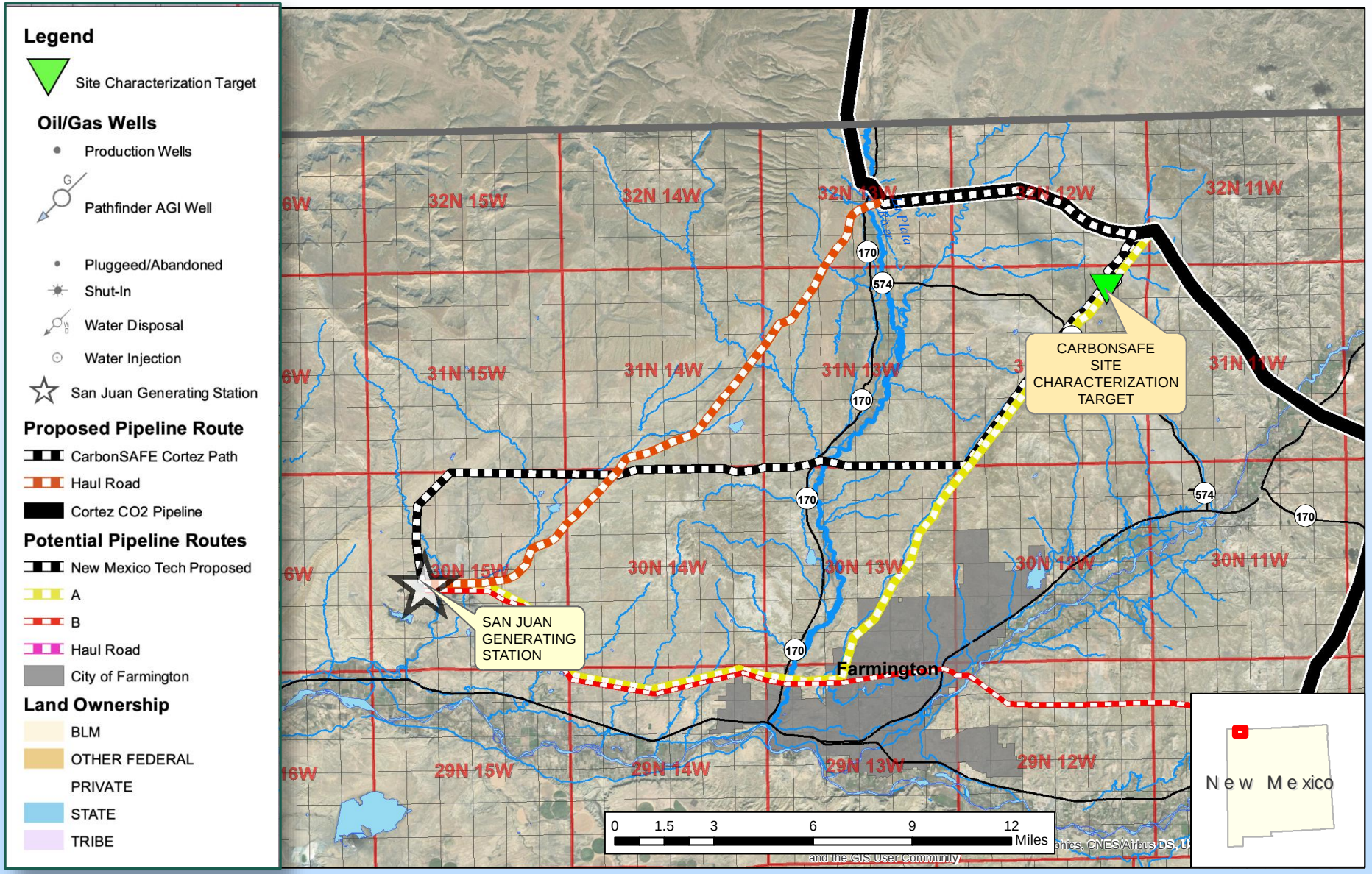
Integration of CO2 Capture, transport and storage/utilization



CarbonSAFE Complex Overview

Proposed CO_2 Transport Pipelines

Integration of CO2 Capture, transport and storage/utilization



CarbonSAFE Complex Overview

Potential CO_2 Transport Pipeline Rights-of-way

Technical Approach/Project Scope

Task/ Subtask	Milestone Title & Description	Planned Completion Date
1.0	Project Kick-off meeting	
2.3	NEPA documentation progress	3/31/2023
3.1	Evaluation of available data such as seismic	12/30/2020
3.3	Acquisition and processing of Seismic data	5/30/2021
3.4.5	Stratigraphic well drilled	7/30/2021
4	Complete needed Caprock and reservoir analysis for Modeling	5/31/2022
5.2	Complete initial simulations for UIC permit application	7/31/2022
5.2.8	Complete AOR modeling	8/31/2022
5.3	Complete initial Risk assessment for UIC permit application	8/31/2022
6	Complete documentation to submit UIC class VI application	9/30/2022
6.10	Progress report on submitted UIC class VI application	3/30/2023
6.10	Progress and/or receiving approval for UIC class VI application	9/30/2023

Technical Approach/Project Scope
(Project Success Criteria)

Objective/ Decision point	Success Criteria
NEPA assessment of selected project location(s) [Task 2]	The selected locations meet NEPA requirements. If not successful we move to a new location.
Obtain permits and drill a stratigraphic well at the selected suitable location. [Task 3]	Successful drilling, logging, and coring of well. If not successful we change location.
Purchasing of available seismic in the selected area [Task 3]	Purchase of existing seismic. If none available, we will acquire a new survey
Detailed site characterization to determine viability of selected storage complex [Task 3 and 4]	Site is found to have suitable geology for large scale CO_2 injection and storage
Modeling results from reservoir model and NRAP used to determine storage potential [Task 5]	Results show selected complex is able to securely store more than 50 million tons of CO_2 in the long term.
Complete application for UIC class VI application [Task 6]	Successful submission of UIC class VI application to EPA.
Secure approval on submitted UIC class VI application [Task 6]	Receiving approval to construct from EPA or the project cannot move forward

Project risks and mitigation strategies

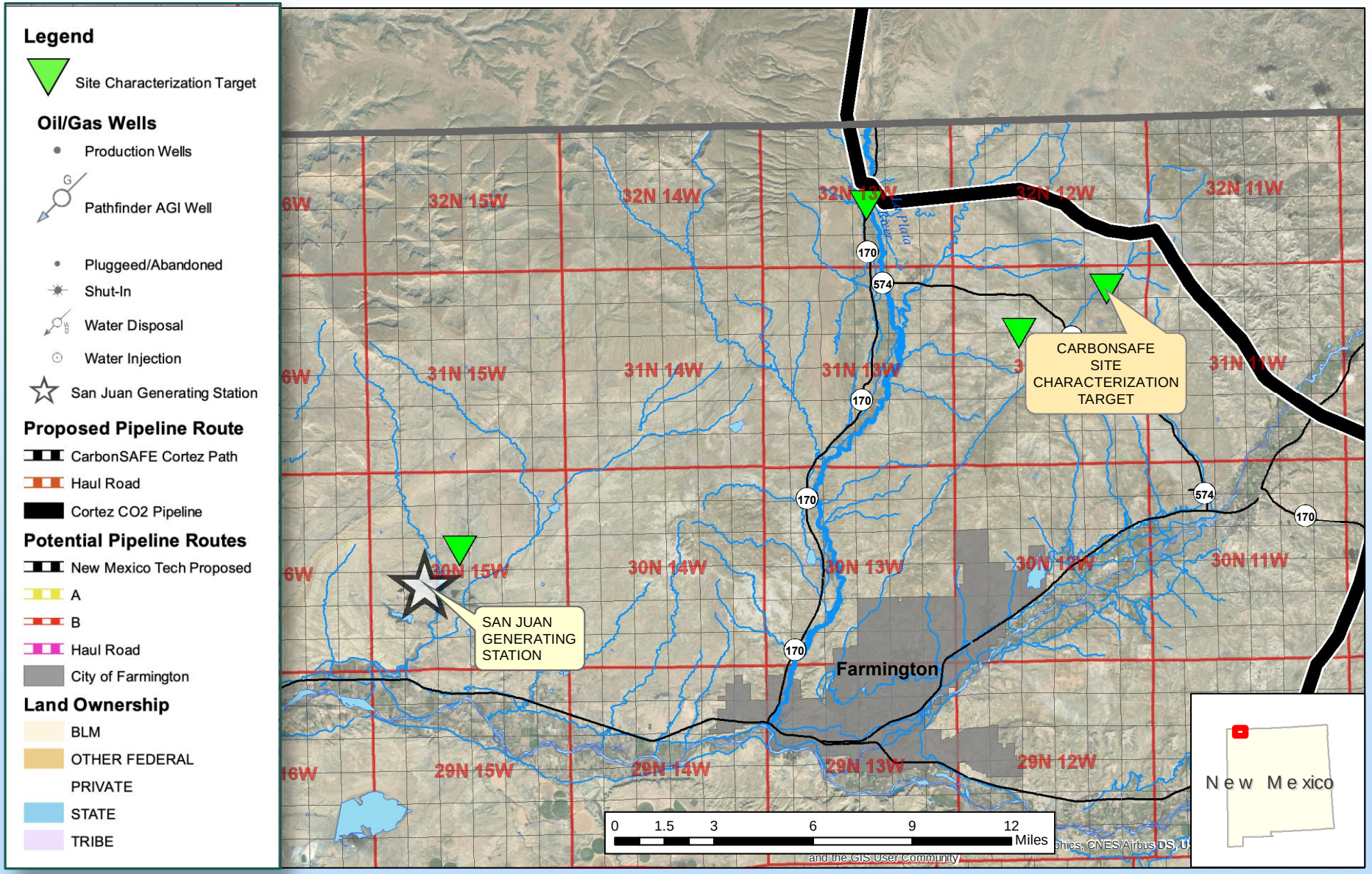
Technical/Scope Risks:	Probability/Impact/Overall			Mitigation
Delays when drilling well	med	High	med	Appropriate management and well design should prevent this from happening. We will monitor drilling activities daily.
Unsuitable geology in identified area	low	High	low	Site location was chosen after a feasibility study by expert geologists with years of experience in the San Juan Basin. This study identified other potential sites in the area that could be used.
Lack of data	low	High	low	The project has identified several sources of commercial data. The New Mexico Bureau of Geology has offered access to databases and well logs for well information throughout the San Juan Basin.
ES&H Risks:				
Safety and environmental Risk	low	High	low	Experienced personnel with appropriate levels of expertise and safety will be handling field operations in the study.
External Factor Risks:				
Site access	low	High	low	We have a letter committing to site access from the operator and surface lessee (Hilcorp Energy) and additional letter from Robert L. Bayless, Producer LLC to use their site as well.
Regulatory Issues	med	High	med	New Mexico does not have a precedent for Class VI CO2 injection so issues of pore space and mineral rights may arise. However, the team has expertise from previous CarbonSAFE projects, regional partnerships and industry to overcome any potential barriers.

Progress and Current Status of Project

Accomplishments to Date

a. Solicited and gained community and industry support within San Juan area
b. Expanded the geologic database with data on target seals and potential CO_2 reservoirs for all available deep wells in the area
c. Utilized available data to estimate storage potential for the storage complex
d. Utilized available data and experience in the study area to select a potential location to drill stratigraphic well
e. Developed preliminary models and conducted simulations to evaluate CO_2 storage capacity and migration pathways within the San Juan Basin
f. Evaluated of existing 3D seismic within the study area
g. Engaged field operator Hilcorp Energy for field access and technical support to accelerate permitting and stratigraphic well drilling process
h. Preliminary scoping of characterization data collection plan (coring, logging, fluid sampling etc)
i. NMT negotiated budget contracting with DOE

Site Selection



CarbonSAFE Complex Overview

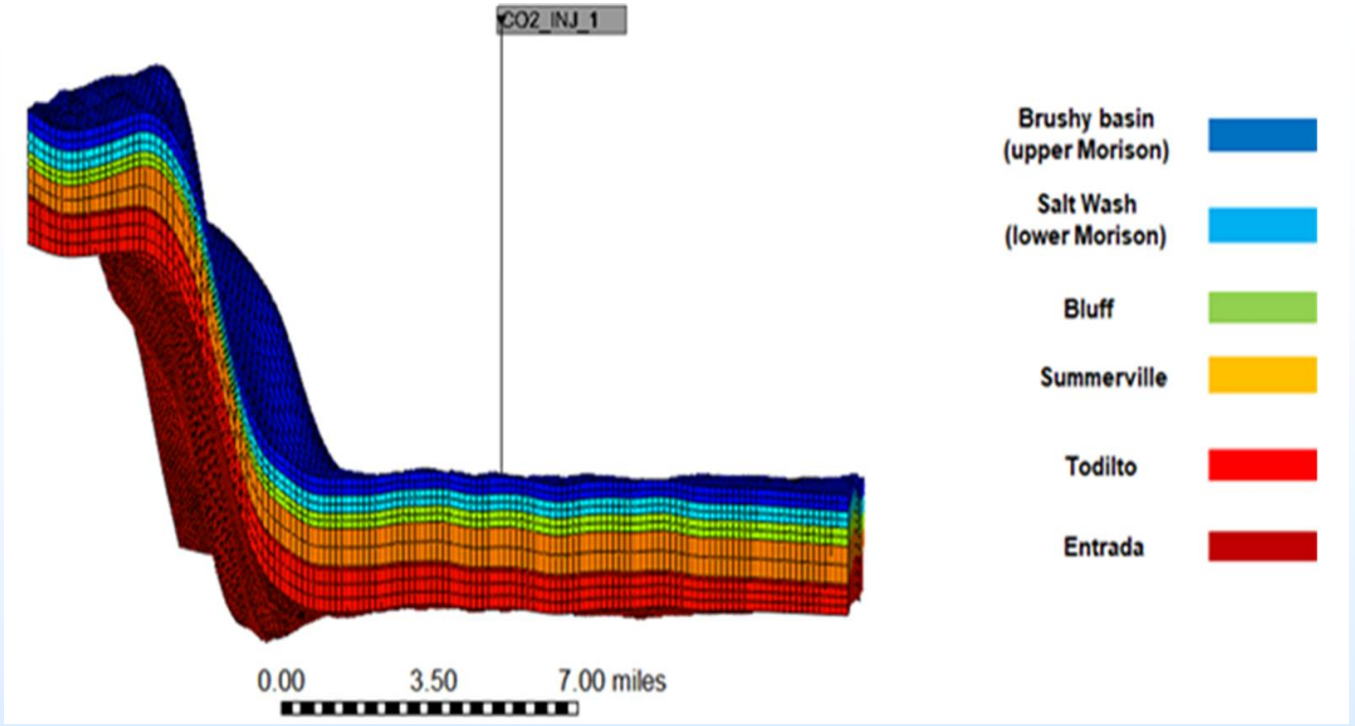
Evaluated site characterization options

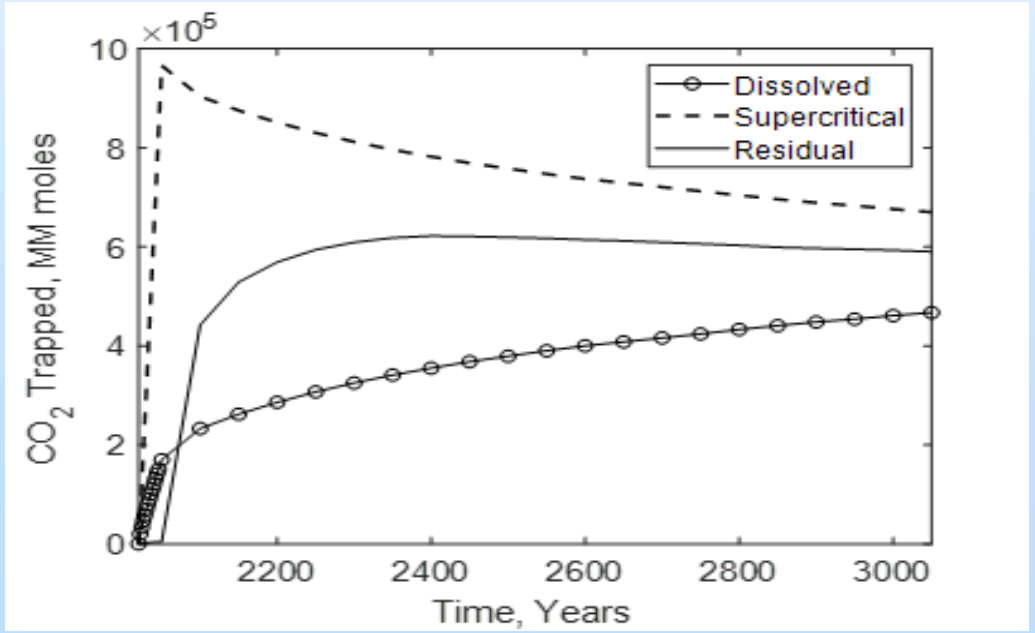
Criteria:

- Accessibility
- Infrastructure
- **Geology**
- Numerical Modeling
- Economics
- Environmental Impact

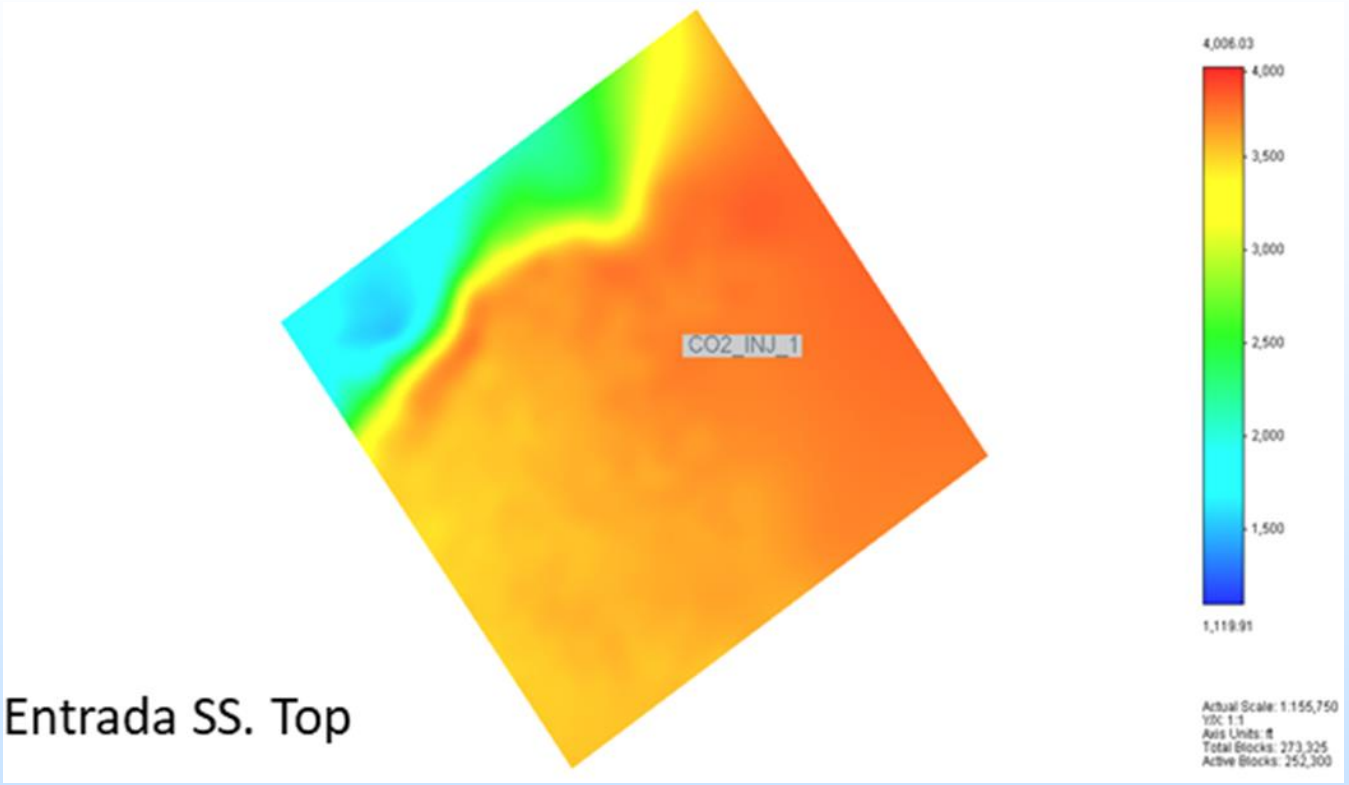
Simulation Model

- Simulation area is 18km by 18km @ Selected location
- Salt Wash member, Bluff and Entrada are the main target saline stacked reservoirs for injection.
- Brushy basin, Summerville, and Todilito are caprocks
- Pressure gradient of 0.44 psi/ft was used to initialize model ~ 3228 psi @ Entrada with 100% saturated with formation water
- Well injects 86 MMSCF/D (4566.21 tonnes/D of 100% CO_2 for 30 years [50 MMtonnes]

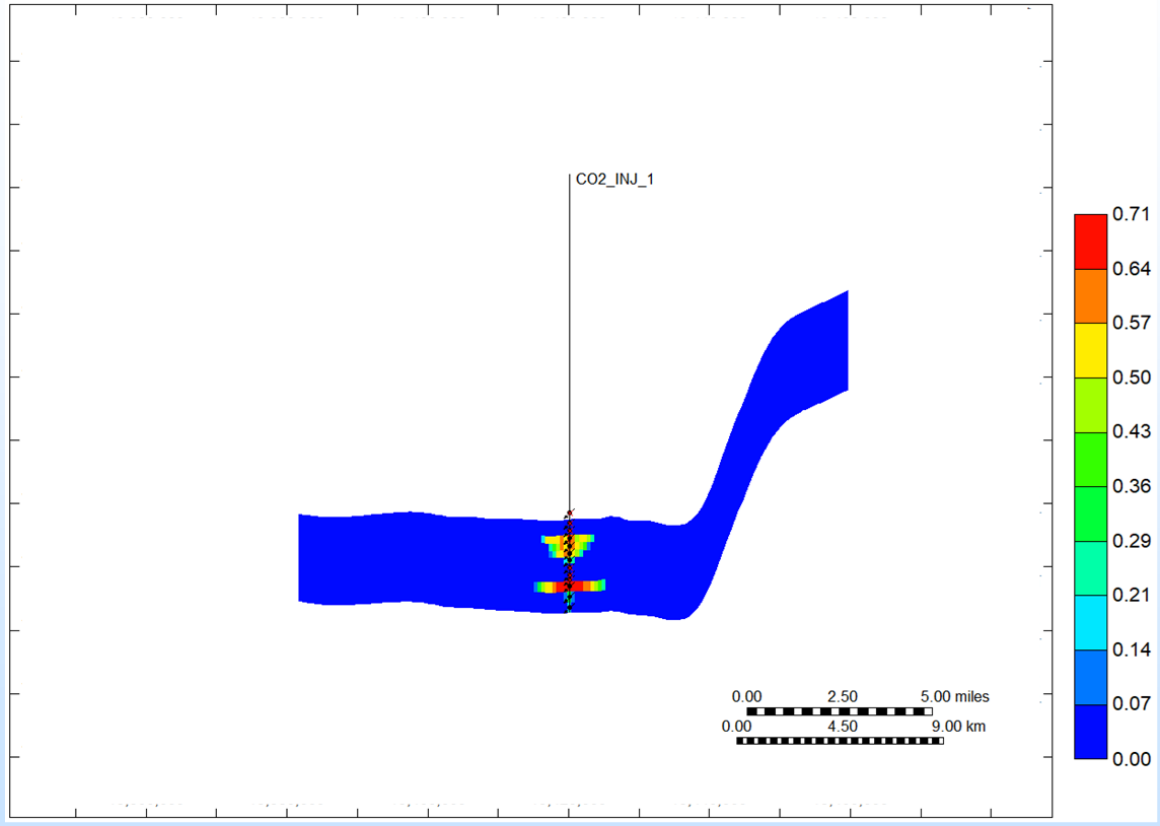




Plume Distribution after 30 year Injection

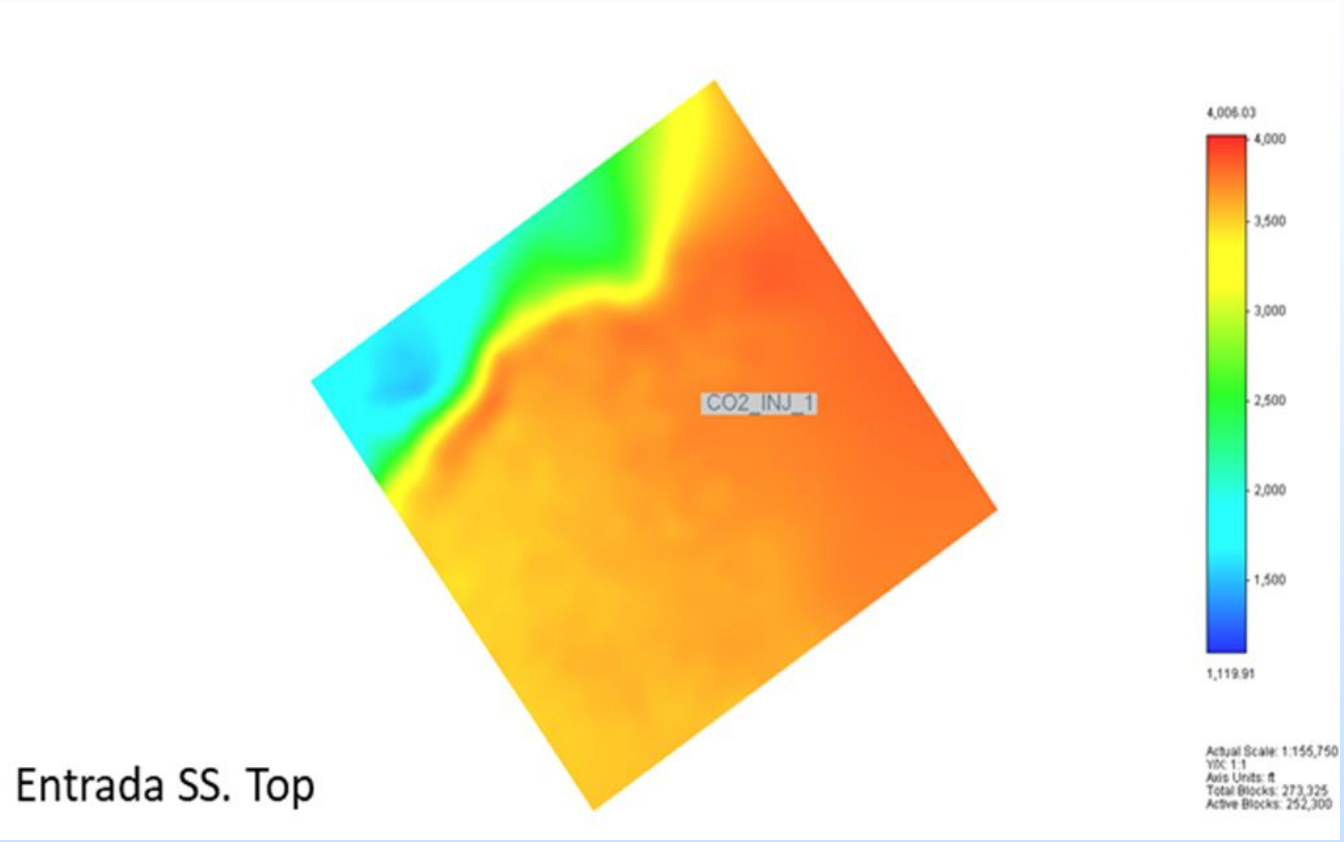


pressure front at the end of 2050 (at the end of injection)

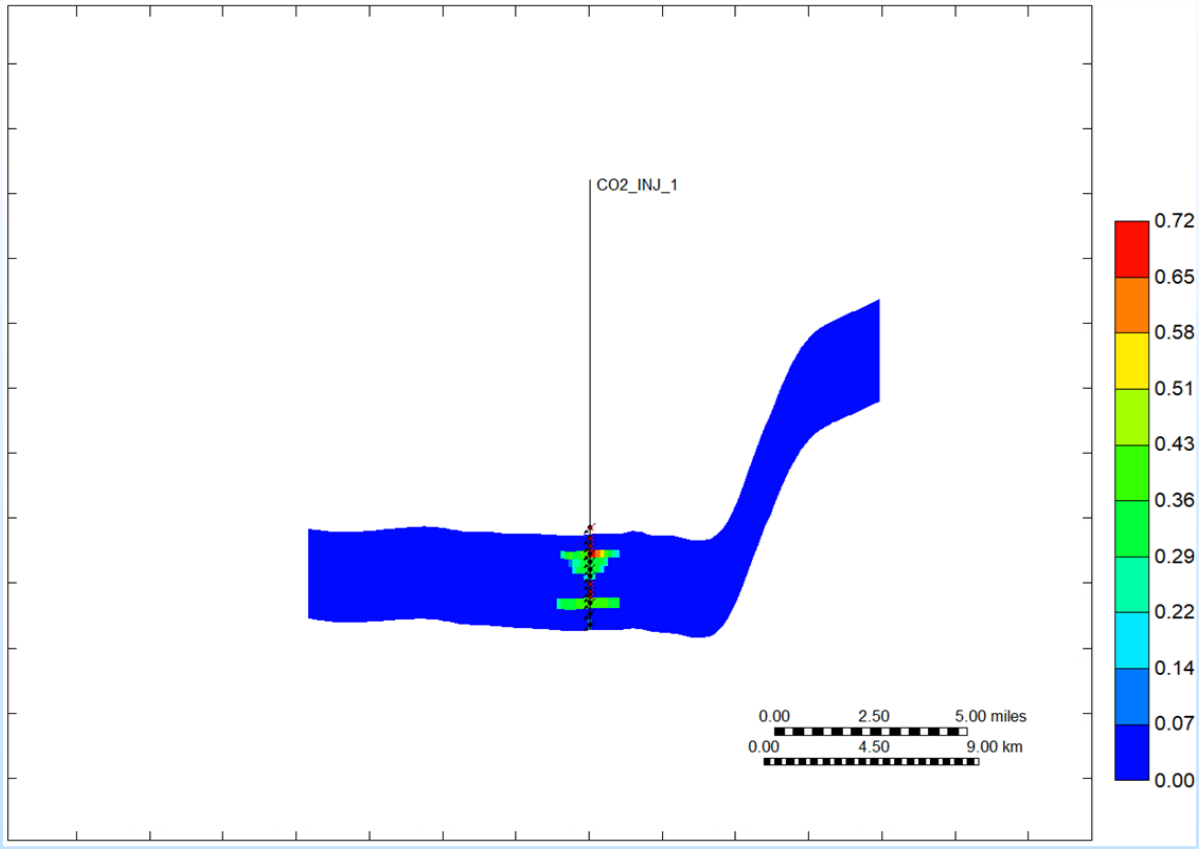


CO_2 plume side view at the end of 2050 (at the end of injection)

Plume Distribution after 1000 years

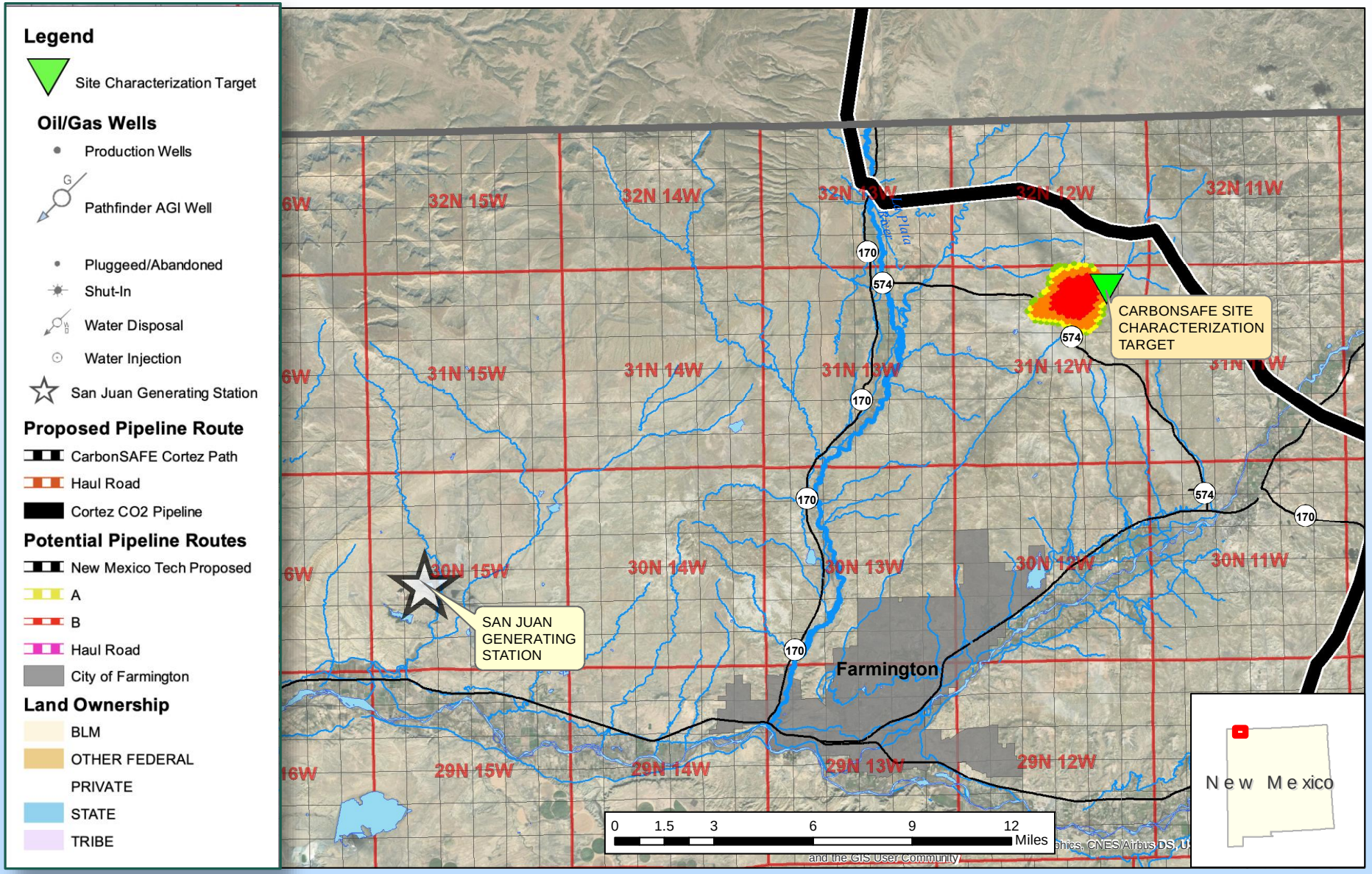


Pressure front at the end of 3050 (1000-year post injection monitoring)



CO_2 plume side view at the end of 3050 (1000-year post injection monitoring)

Integration of CO2 Capture, transport and storage/utilization



CarbonSAFE Complex Overview

CO2 migration

Synergy opportunities

- The team is planning on leveraging on experiences from other CarbonSAFE projects, Regional partnerships such as SWP and Regional Initiatives to ensure success of proposed efforts

- Collaboration with Enchant Energy LLC and its partners to accelerate deployment of CCS technology at the SJGS

- Developing a framework for efficient permitting and regulatory oversight for commercial scale CO_2 storage projects in the state of NM.

Gaps/Challenges/Hurdles

- Availability of adequate data in the area such as 3D surface seismic is challenging
- Potential permit challenges
- Sparse well data penetrating through Entrada which is our main target saline reservoir

Summary- Key findings

a. There is interest in deploying CCS technology to preserve continued operation of the SJGS

b. The geology within San Juan basin has favorable “significant” storage capacity

c. Enchant Energy LLC is a willing and able collaborator and partner

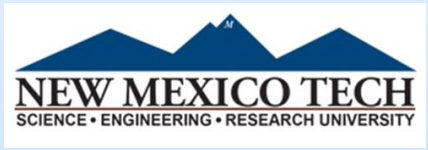
Summary- Next Steps

The overall objective of this proposed project is to perform a comprehensive commercial-scale site characterization of a storage complex located within San Juan County, New Mexico to accelerate the deployment of integrated carbon capture and storage (CCS) technology at the San Juan Generating Station (SJGS).

- Task 1.0 – Project Management and Planning
- Task 2.0 – National Environmental Protection Act (NEPA)
- Task 3.0 – Site Characterization
- Task 4.0 – Reservoir and Caprock Characterization
- Task 5.0 – Geologic Modeling and Simulation
- Task 6.0 – Underground Injection Control (UIC) Class VI Permit Application
- Task 7.0 – Integrated Assessment Modeling
- Task 8.0 – Stakeholder/Policymaker Outreach/Education and Engagement
- Task 9.0 – Coordination with other DOE Projects

Acknowledgements

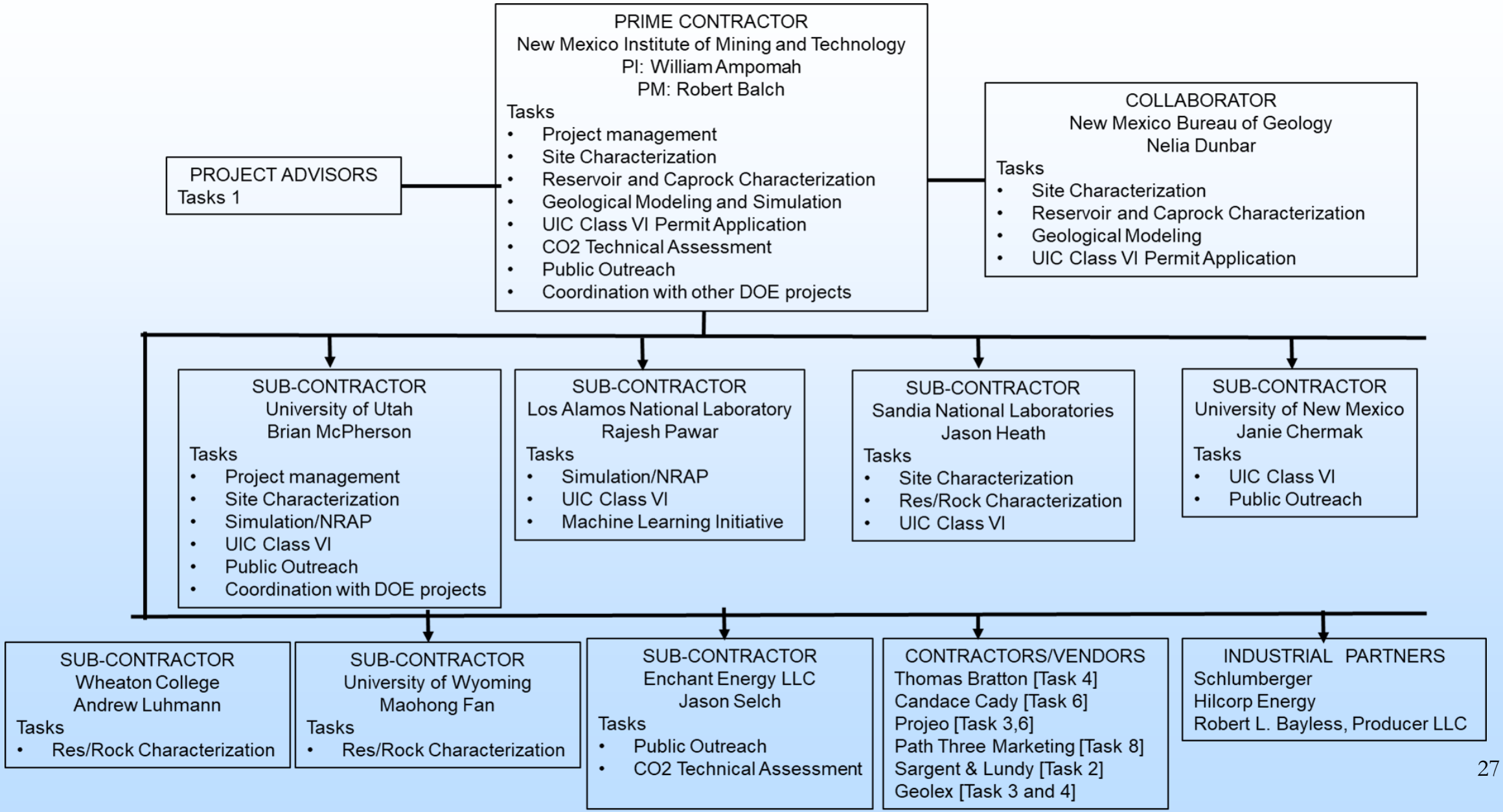
The project would like to thank DOE for the award opportunity through DE-FE0031890 and our partners.



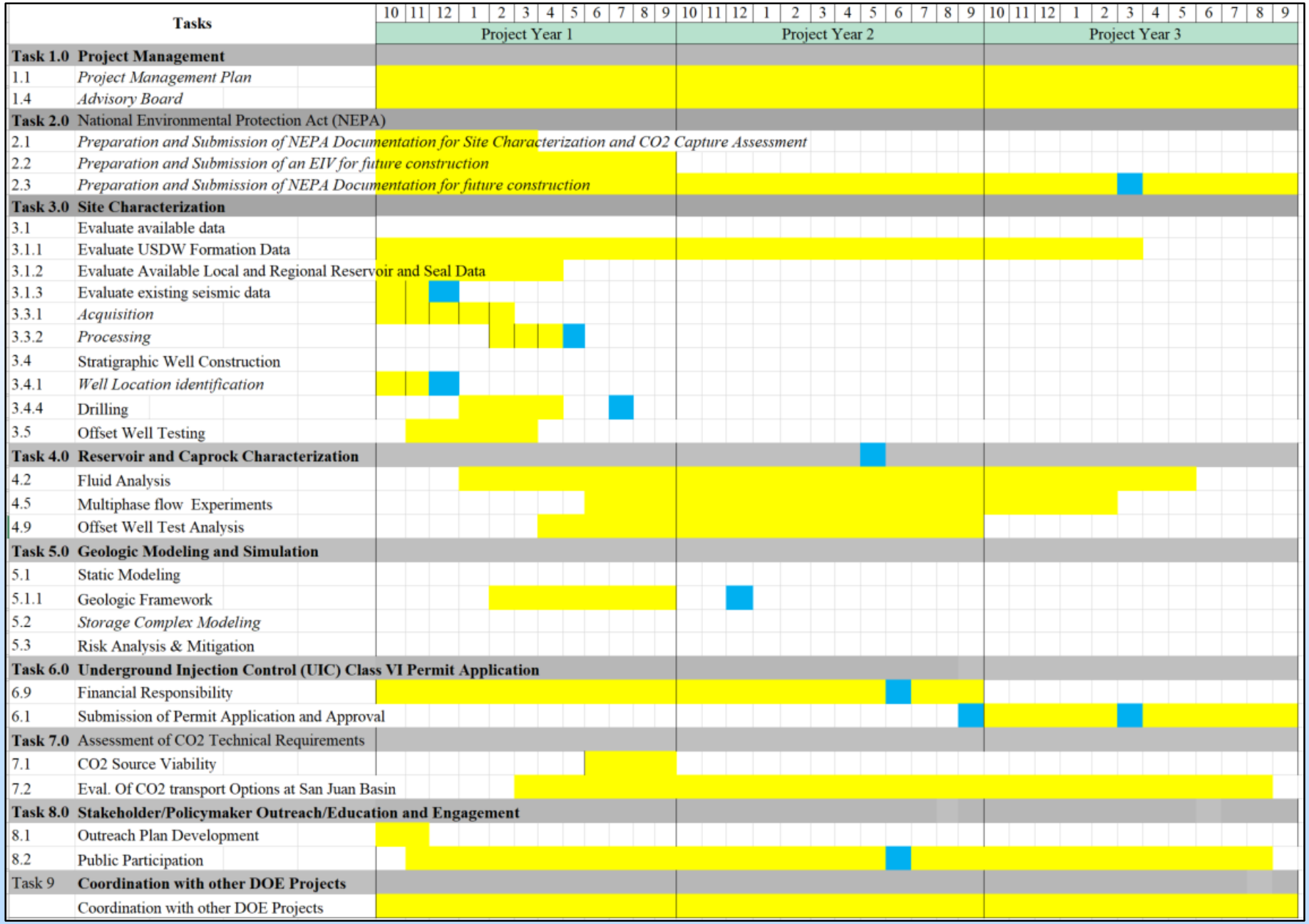
Appendix

– These slides will not be discussed during the presentation, but are mandatory.

Organization Chart



Gantt Chart


Tasks
10 11 12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9
Project Year 1
Project Year 2
Project Year 3
Task 1.0 Project Management
1.1 Project Management Plan
1.4 Advisory Board
Task 2.0 National Environmental Protection Act (NEPA)
2.1 Preparation and Submission of NEPA Documentation for Site Characterization and CO2 Capture Assessment
2.2 Preparation and Submission of an EIV for future construction
2.3 Preparation and Submission of NEPA Documentation for future construction
Task 3.0 Site Characterization
3.1 Evaluate available data
3.1.1 Evaluate USDW Formation Data
3.1.2 Evaluate Available Local and Regional Reservoir and Seal Data
3.1.3 Evaluate existing seismic data
3.3.1 Acquisition
3.3.2 Processing
3.4 Stratigraphic Well Construction
3.4.1 Well Location identification
3.4.4 Drilling
3.5 Offset Well Testing
Task 4.0 Reservoir and Caprock Characterization
4.2 Fluid Analysis
4.5 Multiphase flow Experiments
4.9 Offset Well Test Analysis
Task 5.0 Geologic Modeling and Simulation
5.1 Static Modeling
5.1.1 Geologic Framework
5.2 Storage Complex Modeling
5.3 Risk Analysis & Mitigation
Task 6.0 Underground Injection Control (UIC) Class VI Permit Application
6.9 Financial Responsibility
6.1 Submission of Permit Application and Approval
Task 7.0 Assessment of CO2 Technical Requirements
7.1 CO2 Source Viability
7.2 Eval. Of CO2 transport Options at San Juan Basin
Task 8.0 Stakeholder/Policymaker Outreach/Education and Engagement
8.1 Outreach Plan Development
8.2 Public Participation
Task 9 Coordination with other DOE Projects
Coordination with other DOE Projects