Critical Challenges. Practical Solutions.

Energy & Environmental Research Center (EERC)

North Dakota CarbonSAFE Phase III: Site Characterization and Permitting (FE0031889)

U.S. Department of Energy
National Energy Technology Laboratory
Carbon Management and Natural Gas & Oil Research Project Review Meeting
August 2022

Wes Peck
Energy & Environmental Research Center

Project Overview

GOAL:

- Perform commercial-scale site characterization and permitting for the geologic storage of nearly 4 million metric tons (Mt) of CO_2 per year.

PROJECT TUNDRA

Minnkota Power COOPERATIVE
A Touchstone Energy® Cooperative

EERC
UND UNIVERSITY OF NORTH DAKOTA

U.S. DEPARTMENT OF ENERGY | NETL NATIONAL ENERGY TECHNOLOGY LABORATORY

Industrial Commission of North Dakota
Lignite Research, Development and Marketing Program

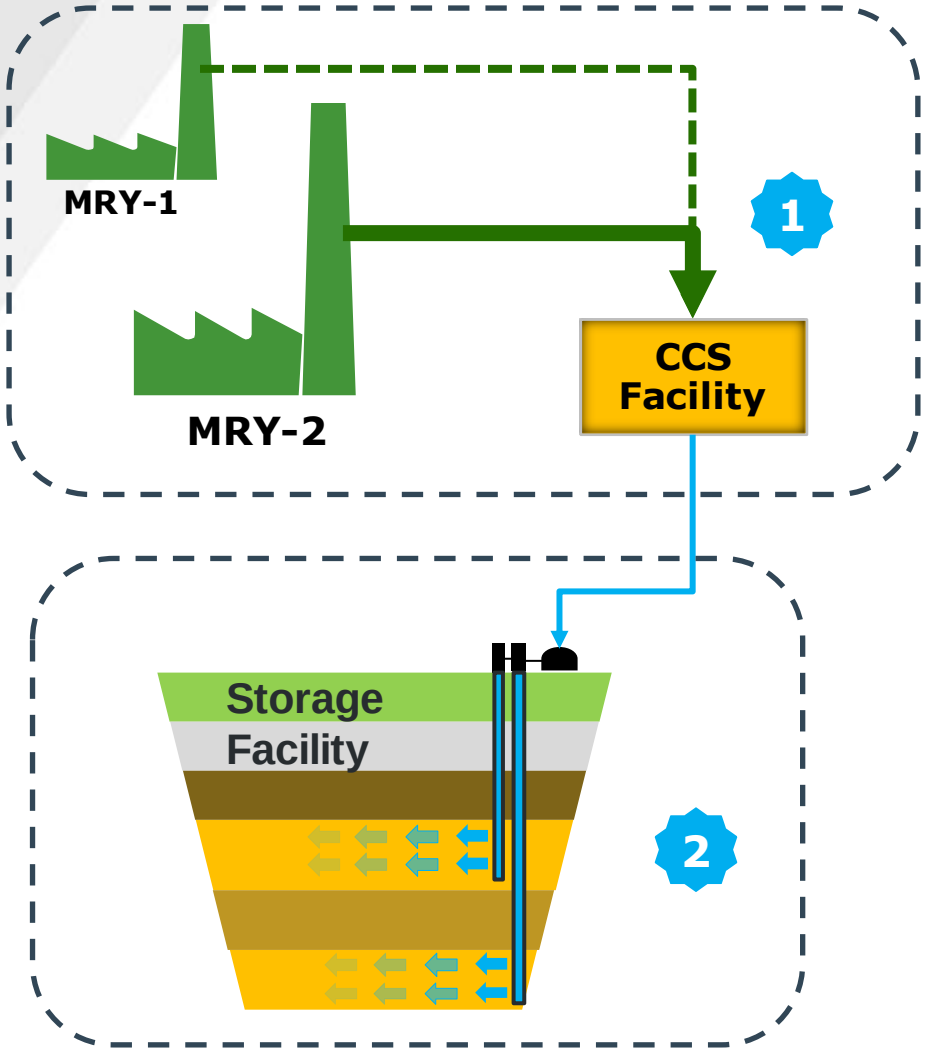
CMG COMPUTER MODELLING GROUP LTD.

Schlumberger

Square Butte ELECTRIC COOPERATIVE

Objective: Accelerate wide-scale deployment of CCUS by assessing and permitting the geologic storage of CO_2 emissions captured from the Milton R. Young Power station.

Project Tundra Overview



Two Projects in One

1. **Divert flue gas then separate CO_2** in a carbon capture system that strips out the CO_2 then liquifies under pressure.

2. **Inject CO_2 into storage formation** over a mile below lignite mine.

No impact on the power plant and no impact on its costs

How Did We Get Here?

- CarbonSAFE Jump Start—Leveraged existing:
  - Partnerships
  - Expertise
  - Methods
  - Regional characterization

Phase I: Integrated CCS Pre-Feasibility
12-18-month initiative

- Formation of a team; development of a feasibility plan; and high-level technical evaluation of the sub-basin and potential CO_2 sources
- Thirteen projects funded

Phase II: Storage Complex Feasibility
18-24-month initiative

- Data collection; geologic analysis; analysis of contractual and regulatory requirements; subsurface modeling; risk assessment; evaluate monitoring requirements; and public outreach
- Six projects funded

Phase III: Site Characterization and Permitting
<3-year initiative

- Detailed site characterization; submit UIC Class VI permit to construct; CO_2 Capture Assessment; NEPA approvals
- Five projects funded
- Phase III.5: NEPA and FEED Studies Only - for applicants who have completed most Phase III activities independent of DOE

Phase IV: Construction
<2.5-year initiative

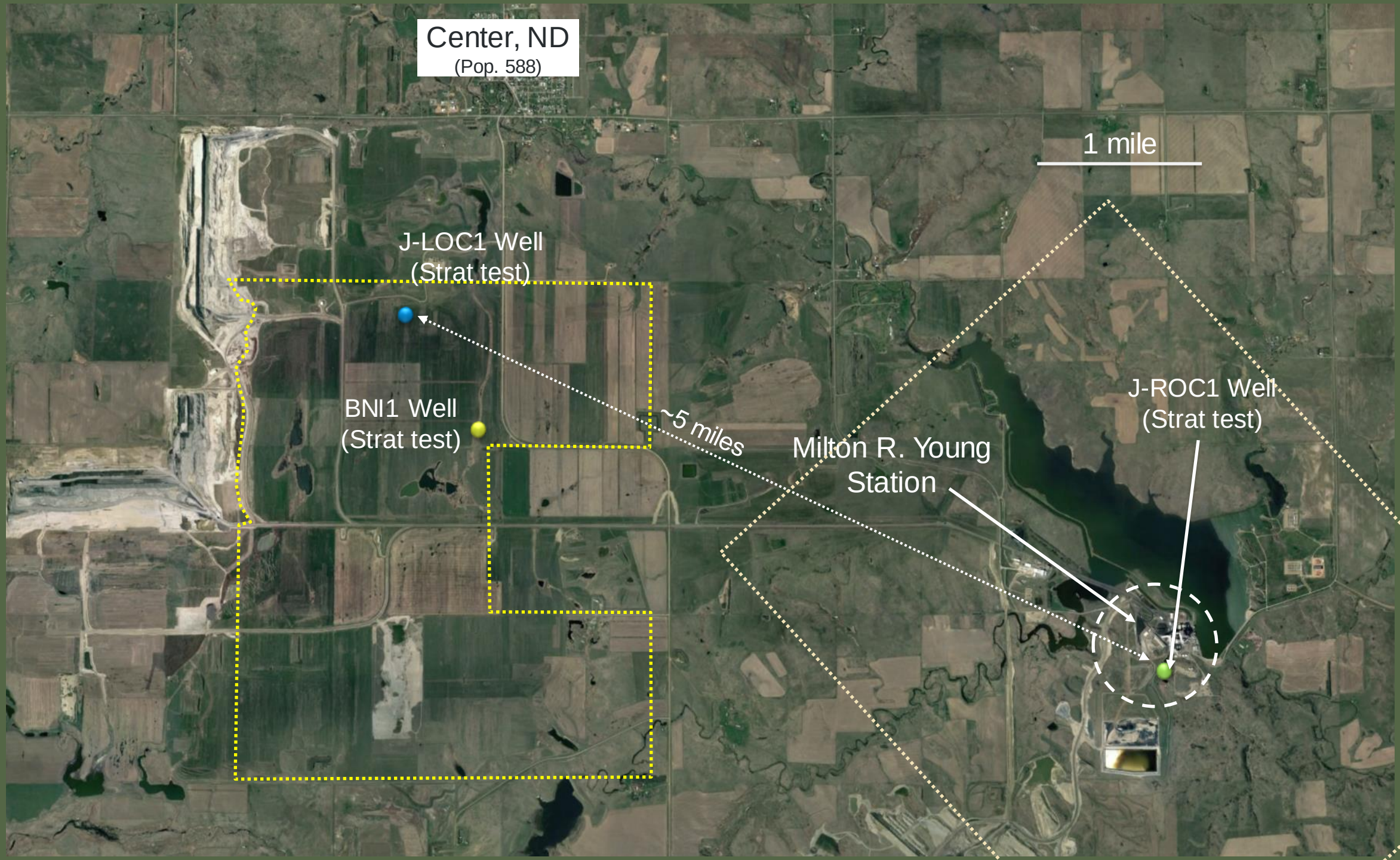
- Obtain UIC Class VI permit to inject; drill and complete injection and monitoring wells; complete risk and mitigation plans
- Subject to funding

Phase III:

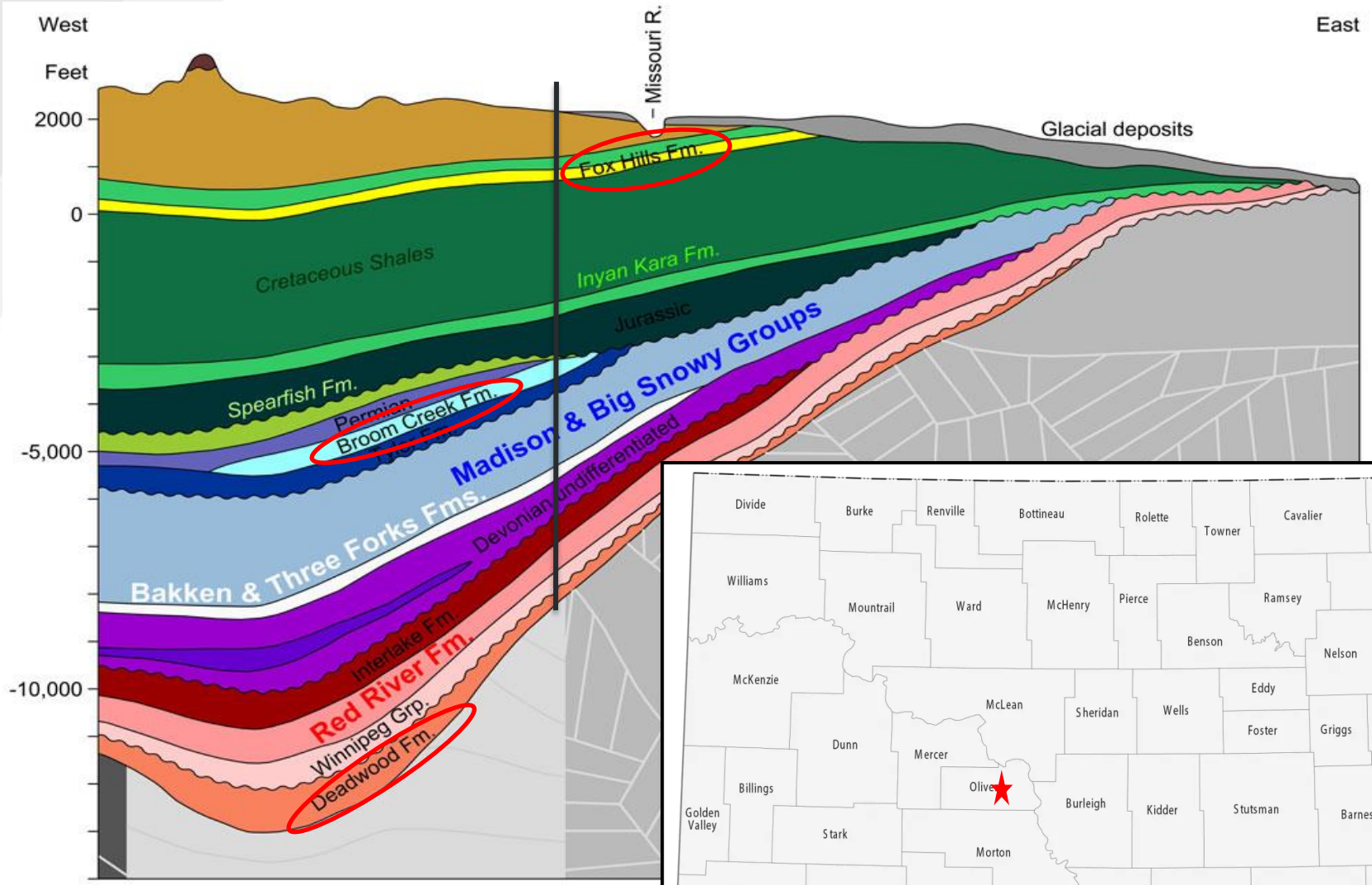
Pre-award 5/1/2020 → J-LOC1 5/14/2020 → J-ROC1 9/8/2020 → Award - BP1 10/1/2020

Bridging Activity

- **CSND Phase II—ended March 31, 2020**
- **CSND Phase III—started one month later!**


Center, ND
(Pop. 588)
1 mile
J-LOC1 Well
(Strat test)
BNI1 Well
(Strat test)
~5 miles
Milton R. Young
Station
J-ROC1 Well
(Strat test)

Project Location



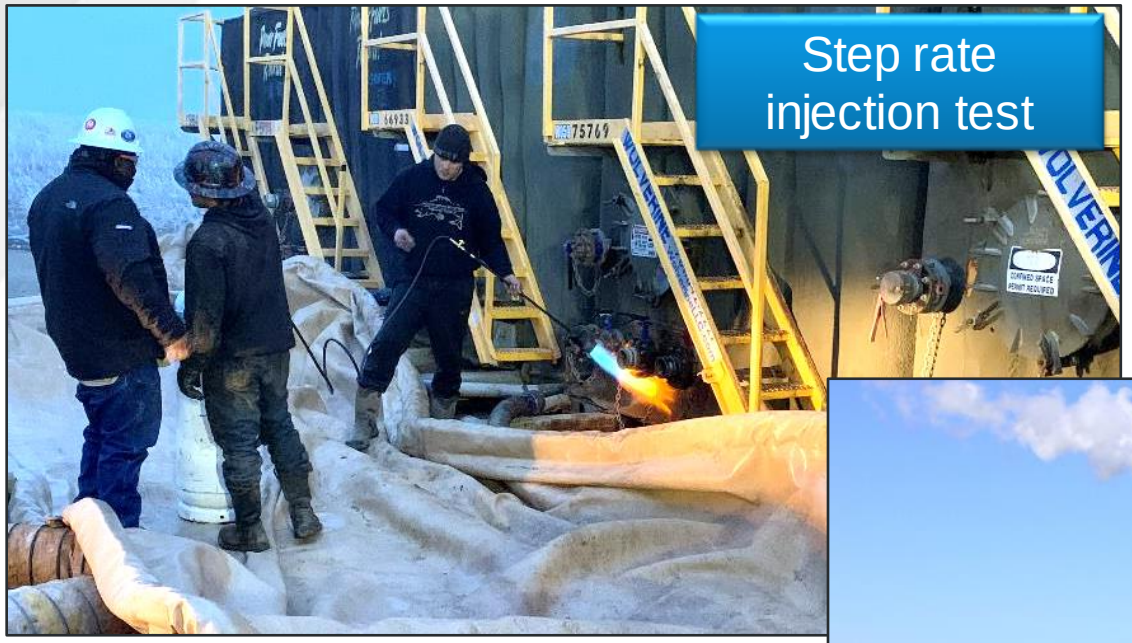
Broom Creek Measured Values
Depth: ~4900 ft
Porosity (%): 2–27
Permeability (mD): 0.06–2690

Black Island/Deadwood Measured Values
Depth: ~9400 ft
Porosity (%): 3.4–15
Permeability (mD): 0.03–2060

Phase III Technical Approach: Address the Needs of the Permit!

Major NDIC Permitting Requirements	Major Proposed Characterization Activities										
	Core	Logging	Downhole Testing	Lab Testing	Modeling	Simulation	Seismic Collection	Baseline Sampling	New Fox Hills Wells		
Determine Plume Extent	X	X	X	X	X	X	X				
Determine Pore Space Amalgamation	X	X	X		X	X	X				
Geologic Properties of Injection and Confining Zones	X	X	X	X							
Regional Faulting Assessment	X						X				
Potential for Seismic Activity			X		X		X				
Geologic Maps and Cross Sections		X			X		X		X		
Geomechanics of Confining Zones(s)		X	X	X	X						
Identify and Characterize Secondary Confining Zones		X	X		X		X				
Determine Area of Review		X	X	X	X	X	X	X	X		
Baseline Geochemical Data	X			X				X	X		
Baseline Water and Soil Data				X				X	X		

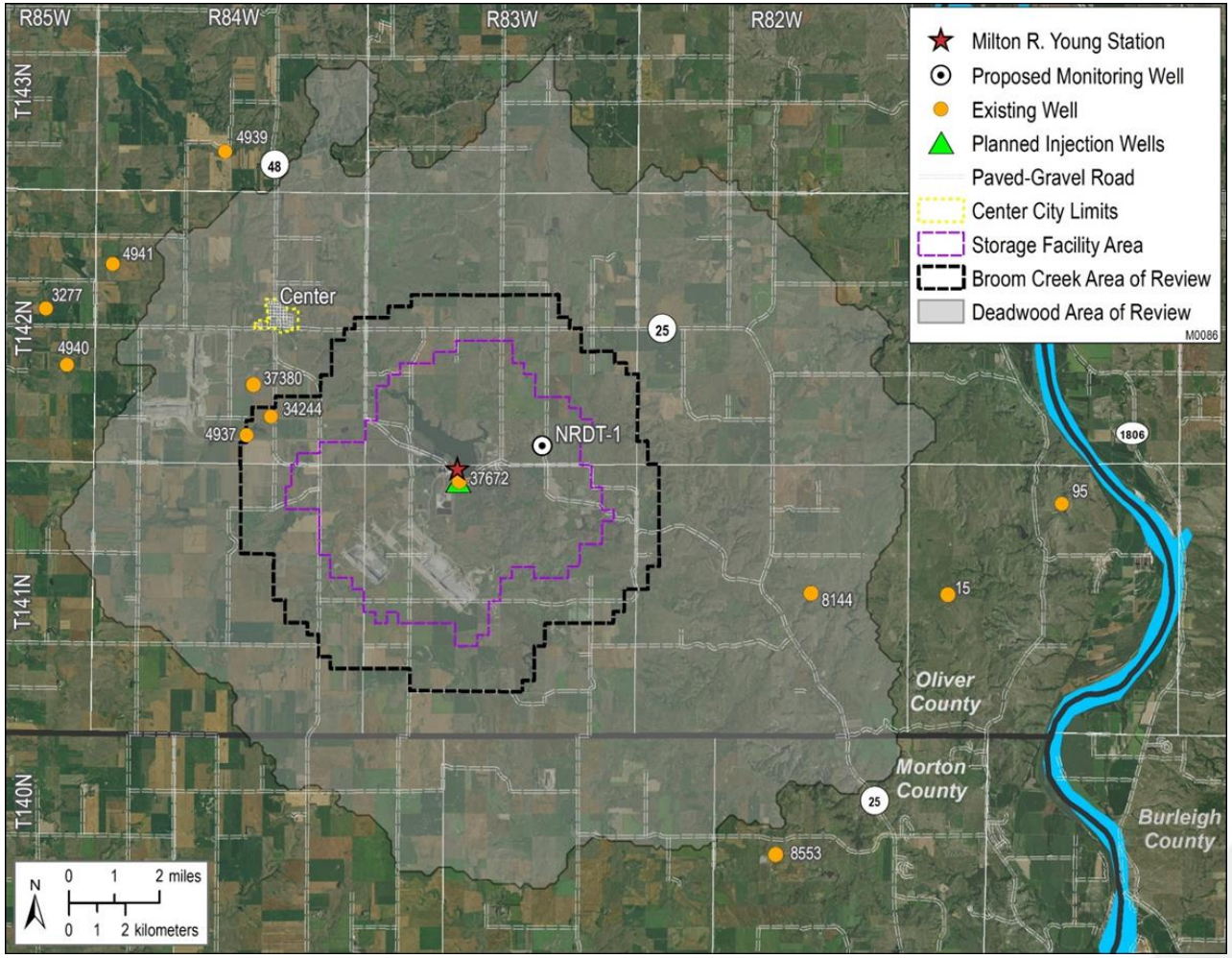
Data Collection



Pore Space and Area of Review

- Pore Space Access:
  - ~50 parcels of land
  - ~60 different landowners
  - >95% voluntary enrollment

- Area of Review (AOR)—risk-based approach for over-pressured formations (Broom Creek Formation)



Public Hearing

Combined applications were **1200+ pages**

Over 7 hours of testimony and responding to public comments

First coal-fired power plant permitted to store CO_2

CarbonSAFE North Dakota Storage Facility Permits—Approved January 21, 2022

MRV Plan Development and Approval

- Develop an EPA-compliant MRV plan to meet the requirements of the IRS 45Q tax incentive program.
- The MRV plan is founded on the storage facility permit application “testing and monitoring plan” and complements the ND Class VI UIC reporting requirements.

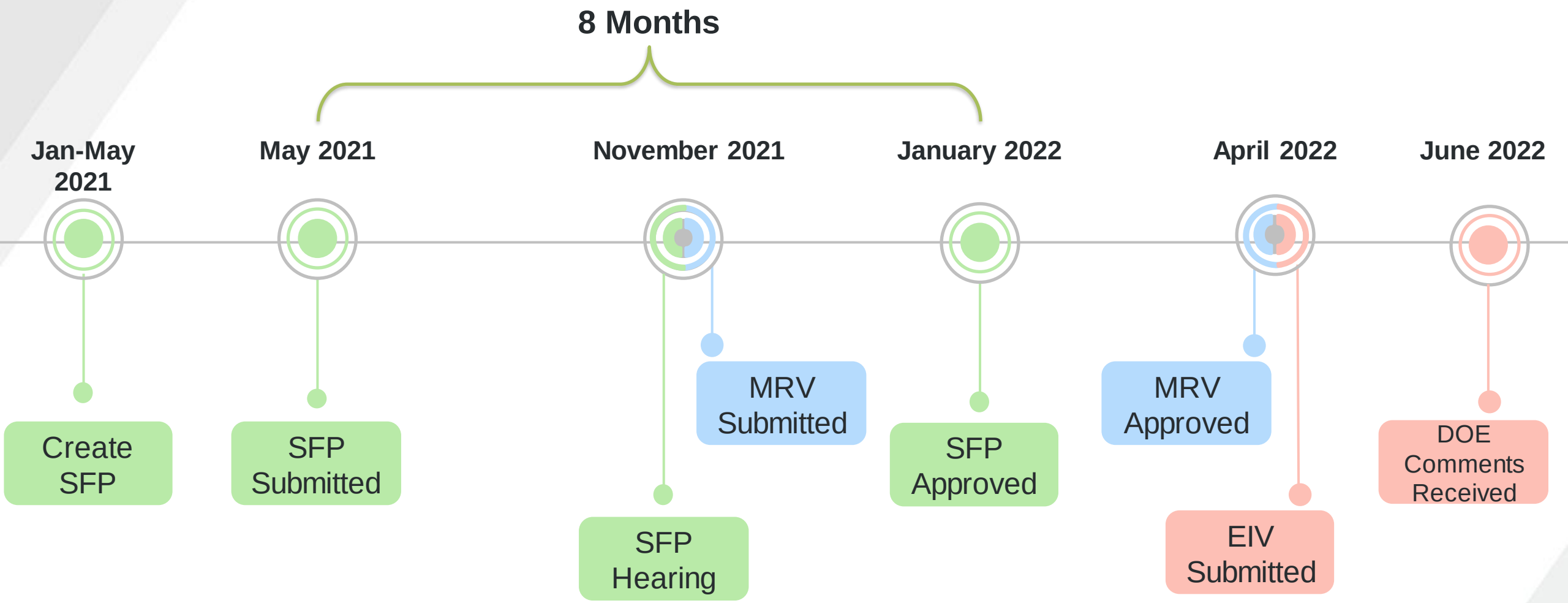
MRV plan submitted November 2021.

MRV plan approved April 2022.

EIV Submitted

- Verbal approval
- Preparing to begin the Environmental Assessment (EA)

Timeline


8 Months
Jan-May 2021
May 2021
November 2021
January 2022
April 2022
June 2022
Create SFP
SFP Submitted
SFP Hearing
MRV Submitted
SFP Approved
MRV Approved
EIV Submitted
DOE Comments Received

Lessons Learned

- Injection tests are worth it.
- Scenario iteration takes time—every answer generates more questions.
- Pore space acquisition takes more time than you think.
- Working in a state with Class VI primacy—priceless.
- Great partners make a difference!

Where Are We Today

- NDIC administrative orders signed for two SFPs
- Received approval for Class VI injection wells
- MRV plan approved
- EIV document verbal approval

- Future activity:
  - Install injection wells and monitoring well
  - File for permit to inject when CO_2 is available.

For More Information

www.dmr.nd.gov/dmr/oilgas/ClassVI

CO2 Storage Facility Permit Requests:

- **Applicant:** Dakota Gasification Company
  - NDIC Case No. 29450 - Draft permit, fact sheet, and storage facility permit application

CO2 Storage Facility Permits Issued:

- **Applicant:** Minnkota Power Cooperative, Inc.
  - Order 31583 – Minnkota Power Cooperative – Geologic storage of carbon dioxide, Broom Creek Formation, Oliver County
  - Order 31584 – Minnkota Power Cooperative – Amalgamation of storage reservoir pore spacing, Broom Creek Formation, Oliver County
  - Order 31585 – Minnkota Power Cooperative – Determination of financial responsibility for geologic storage of carbon dioxide, Broom Creek Formation, Oliver County
  - Order 31586 – Minnkota Power Cooperative – Geologic storage of carbon dioxide, Deadwood Formation, Oliver County
  - Order 31587 – Minnkota Power Cooperative – Amalgamation of storage reservoir pore spacing, Deadwood Formation, Oliver County
  - Order 31588 – Minnkota Power Cooperative – Determination of financial responsibility for geologic storage of carbon dioxide, Deadwood Formation, Oliver County
  - NDIC Case No. 29029 - Draft permit, fact sheet, and storage facility permit application
  - NDIC Case No. 29032 - Draft permit, fact sheet, and storage facility permit application

- **Applicant:** Red Trail Energy LLC
  - Order 31453 – Geological storage of carbon dioxide from Red Trail Energy
  - Order 31454 – Amalgamation of the storage reservoir pore space/Red Trail Energy
  - Order 31455 – Determination of financial responsibility/Red Trail Energy
  - NDIC Case No. 28848 - Draft Permit, fact sheet, and storage facility permit application

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THANK YOU

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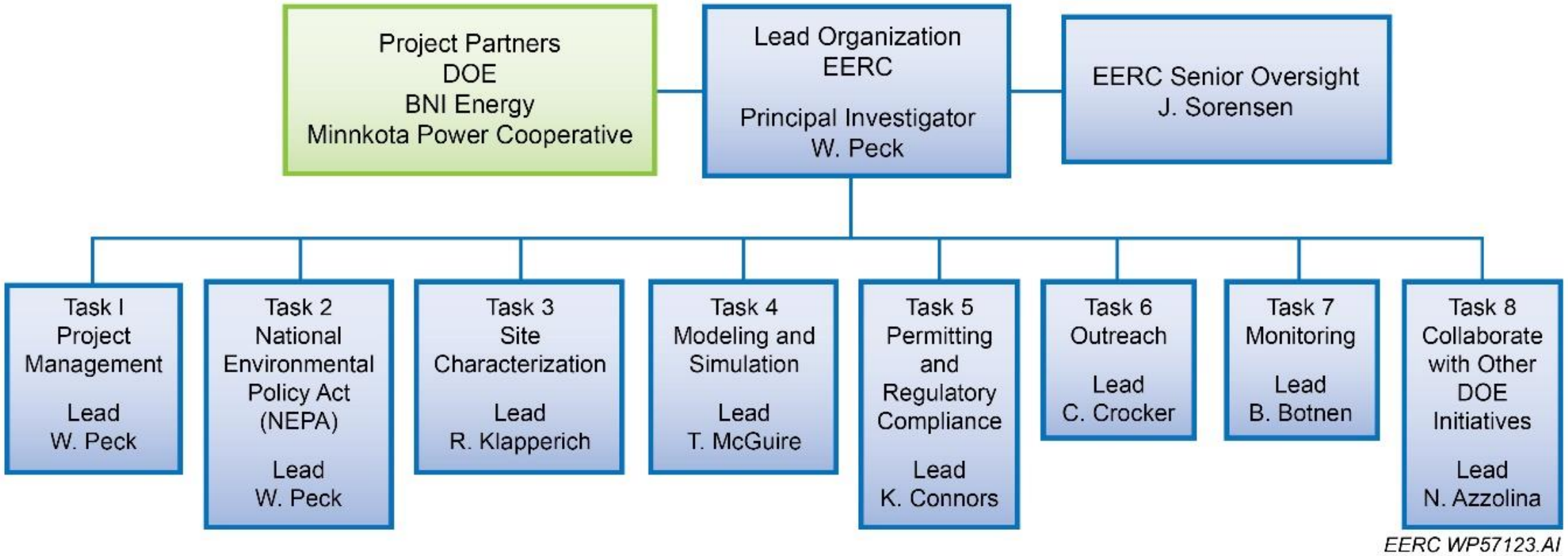
Appendix

Organization Chart



Project Overview

Objective:

- Perform commercial-scale site characterization and permitting for the geologic storage of nearly 4 million metric tons (Mt) of CO_2 per year.

Funding	DOE	Cost Share	Project Total
Dollars (MM)	$16.97	$7.96	$24.93
Contribution	68%	32%	100%

- Performance dates:
  - BP1: October 2020 - September 2022
  - BP2: October 2022 - September 2023

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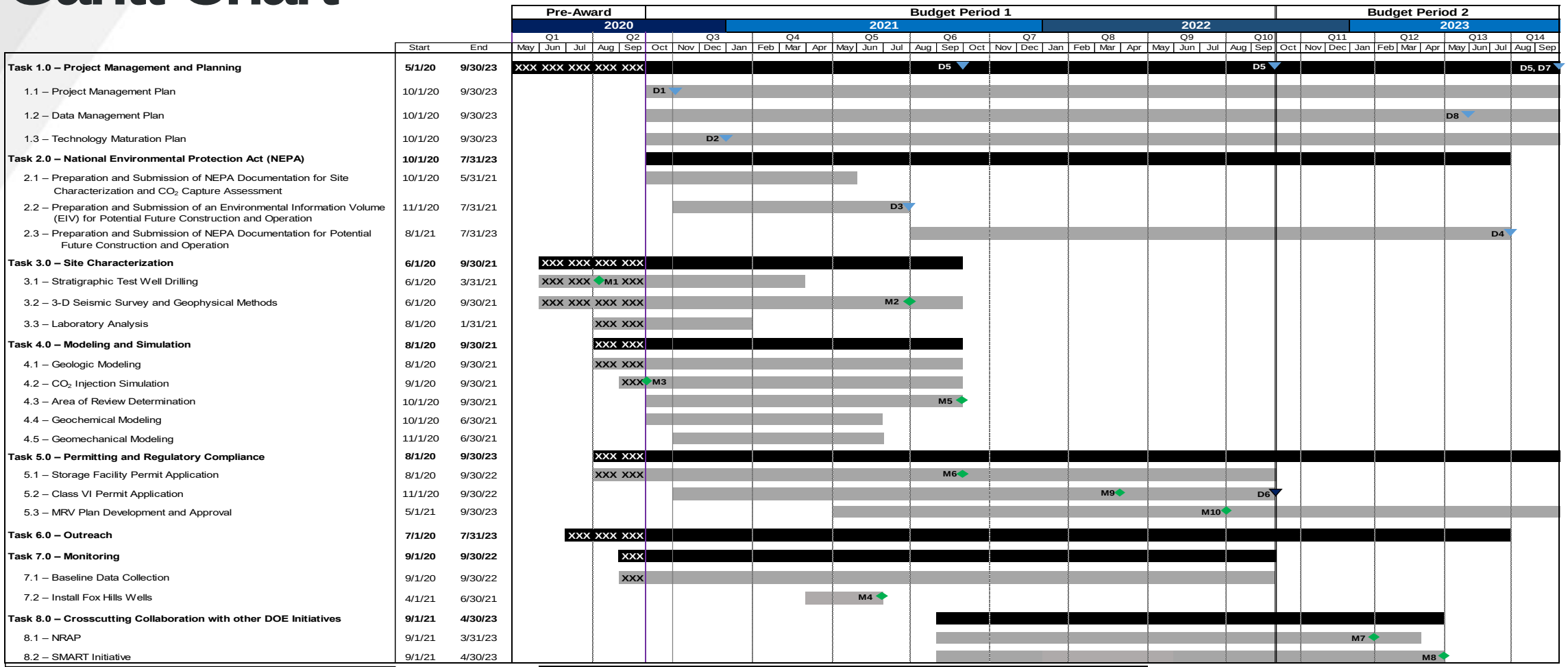
Gantt Chart



Task Duration	
Subtask Duration	

Award Date (10/1/20)

Pre-Award Activity XXX
Pre-Award Activity XXX

Deliverables (D)
D1 – Project Mangement Plan (PMP)
D2 – Carbon Capture Technology(ies) Maturation Plan (TMP)
D3 – Environmental Information Volume
D4 – NEPA Documentation
D5 – Geologic Catalog of Materials
D6 – Topical Report – Summary of Storage Facility and Class VI Well Permit Applications
D7 – Final Technical Report
D8 – Data Submitted to NETL EDX

Milestones (M)
M1 – Submit Permit to Drill
M2 – Geophysical Data Acquisition Complete
M3 – Simulations Initiated
M4 – Fox Hills Well Installation Complete
M5 – Area of Review Determined
M6 – Storage Facility Permit Application Complete
M7 – NRAP Supplemental Testing Complete
M8 – ML Algorithm Testing and Evaluation
M9 – Class VI Permitting Status Presented to DOE Project Manager
M10 – MRV Progress Presented to DOE Project Manager

11.25.20 nsk

Project Overview – Goals and Objectives

- The goal of the proposed effort is to accelerate wide-scale deployment of CCUS by assessing and permitting two safe, cost-effective, commercial-scale storage sites within a storage complex for CO_2 emissions captured from MRYS in central North Dakota. Achieving the goal of Phase III will require acquisition, analysis, and development of geologic information to fully characterize a storage complex in the region around MRYS to demonstrate storage resources for commercial volumes of CO_2.

- Through the proposed effort, the following key activities will be performed: 1) identify and characterize two commercial-scale CO_2 stacked storage sites; 2) apply and obtain approval for an UIC Class VI permit to construct each proposed injection well; and 3) prepare an Environmental Information Volume (EIV) to assess any NEPA (National Environmental Protection Act)-related issues for the identified capture, transport, and storage sites.

Success Criteria

BP1

Subtask 3.1 – Submit Permit to Drill (M1). By November 30, 2020, a stratigraphic test well permit will be submitted to drill the well. The activity is necessary to collect core from each reservoir of interest and perform a suite of laboratory analyses and logging suites to supplement existing knowledge of the storage complex from CarbonSAFE Phase II. Completed August 14, 2021

Subtask 3.2 – Geophysical Data Acquisition Complete (M2). By July 31, 2021, 3-D seismic survey data acquisition will be complete. The data will serve to update geocellular modeling efforts in the storage complex and are a critical component for establishing the storage facility permits for each reservoir (M6). Completed June 19, 2021

Subtask 4.3 – Area of Review Determined (M5). By September 30, 2021, the area of review will be determined for the proposed CO_2 storage program which is required to satisfy storage facility permit applications (M6). Completed June 19, 2021

Subtask 5.1 – Storage Facility Permit Application Complete (M6). By September 30, 2021, the storage facility permit application will be completed and submitted to the North Dakota Industrial Commission. Completed May 28, 2021

Success Criteria Continued

BP2

Subtask 8.1 – NRAP Supplemental Testing Complete (M7). By January 31, 2023, work would expand upon the initial testing done for North Dakota CarbonSAFE Phase 2 and either a) test new versions of existing NRAP tools or b) test existing NRAP tools using newly generated simulation outputs. The results of the testing would be included in the final report and would not be a standalone deliverable. Completed

Subtask 8.2 – ML Algorithm Testing and Evaluation (M8). By April 30, 2023, ML algorithms developed through the SMART Initiative Task 4 would be applied to North Dakota CarbonSAFE.

Phase III data to test and evaluate the performance of one or more ML algorithms against numerical reservoir simulations. The results of the testing would be included in the final report and would not be a standalone deliverable.