FACTSHEET FOR PARTNERSHIP DEMONSTRATION TEST

Partnership Name	Plains CO_2 Reduction (PCOR) Partnership – Phase III	
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Principal Investigator	Edward Steadman	
Field Test Information: Field Test Name	Williston Basin Demonstration Test	
Test Location	Williston Basin, North Dakota	
Amount and Source of CO_2	Tons 500,000 to 1,000,000 tons of CO_2 per year	Source Basin Electric Power Cooperative's Antelope Valley Station
Field Test Partners (Primary Sponsors)	Encore Acquisition Company	
	Basin Electric Power Cooperative	

Summary of Field Test Site and Operations:

This demonstration will inject CO_2 into a saline formation in the Williston Basin for the dual purpose of sequestration and enhanced oil recovery (EOR). The demonstration will transport between 500,000 and 1,000,000 tons per year of CO_2 from Basin Electric Power Cooperative's Antelope Valley Station (an existing conventional coal-fired power plant in central North Dakota) and inject the CO_2 into an oil reservoir operated by Encore Acquisition Company located in western North Dakota or eastern Montana. The power plant will be retrofitted with a system that can capture CO_2 from its flue gas stream. A slipstream of roughly 16% of the plant's total flue gas output (32% of one MW unit) will be processed to separate and capture the CO_2, dehydrated, compressed to supercritical conditions, combined with supercritical CO_2 from the Great Plains Synfuels Plant (GPSP), and transported via pipeline to the sequestration site that is anticipated to be approximately 150 miles away (see Figure 1).

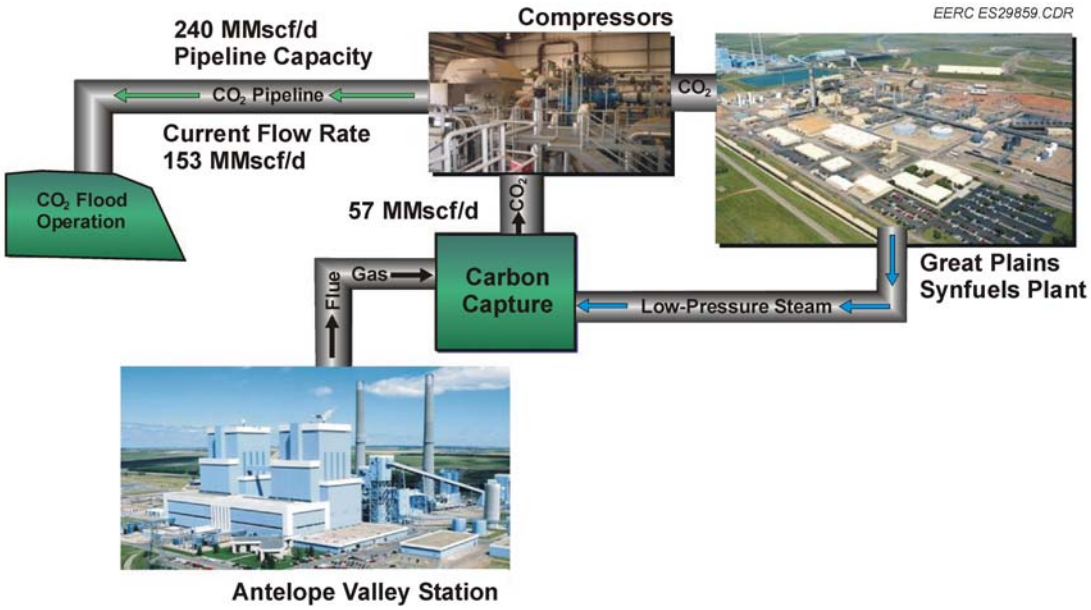


Figure 1. Basin Electric Power Cooperative CO_2 optimization project.

While a specific oil field has not yet been chosen to be the host site for the Williston Basin large-volume CO_2 injection test, it is anticipated that the selection will take place in the early stages of Phase III. The results of the regional characterization activities conducted under Phases I and II of the PCOR

Partnership show that there are at least 40 unitized oil fields in North Dakota and Montana that are likely suitable for CO_2-based EOR operations. There are several major areas of opportunity for 500,000- to 1 million-ton/year CO_2-based EOR projects in the Williston Basin.

GPSP is a commercial-scale coal gasification plant that manufactures natural gas and other chemicals from a lignite fuel source. Located 5 miles northwest of Beulah, North Dakota, GPSP is owned and operated by Dakota Gasification Company (DGC). GPSP gasifies lignite coal to produce valuable gases, liquids, and by-products (including CO_2). GPSP delivers CO_2 to the Weyburn Unit in Canada via 205 miles of 14" and 12" carbon steel pipe. For the purposes of planning and budgeting, it is anticipated that new pipeline and infrastructure will have to be constructed for the Phase III test. Because the operation will include an EOR component, it is also likely that, at some point in the operation (likely in the later years of Phase III), a considerable volume of CO_2 will be produced with the oil, requiring infrastructure and equipment for capturing, recompressing, and reinjecting the recycled CO_2. Thus, site design may include capture and compression equipment for CO_2 processing, pumps for CO_2 injection, and equipment for monitoring (e.g., pressure, temperature and strain gauges, and fluid sampling equipment). It is expected that monitoring activities will include both borehole and surface monitoring tools, along with wireline logging techniques. Use of tracers, fluid sampling, pressure, and deformation monitoring along with numerical modeling will be applied to definitively determine the subsurface area affected by the injection.

Research Objectives:

The primary objective of the Williston Basin test is to verify and validate the concept of utilizing the region's large number of oil fields for large-scale injection of anthropogenic CO_2. Rigorous and cost-effective programs for baseline site characterization, risk assessment, and monitoring, mitigation, and verification (MMV) will be conducted. The Williston Basin CO_2 project will develop detailed and previously unavailable insight regarding a wide variety of issues associated with the geological sequestration of CO_2. The primary research and development targets are summarized below:

- This demonstration will likely result in the deepest (~10,000 feet) EOR/CO_2 sequestration project ever undertaken. The attendant temperature and pressure regimes will provide opportunity to test the engineering effects of extreme depth on EOR and CO_2 sequestration.

- Opportunities for commercialization of anthropogenic carbon management through the use of large-scale CO_2 injection operations in oil fields will be established and facilitated. Capture and injection test data and regional characterization data will be used to evaluate the hypothesis that similar types of geological sinks can provide sufficient storage capacity and commercialization opportunities for large stationary CO_2 sources throughout the region.

- Approaches to develop capacity estimates for the thousands of oil fields in the region as part of PCOR Partnership Phases I and II will be field-tested, refined as necessary, verified, and validated. MMV technologies will be deployed, in part, to substantiate capacity estimates.

- Modeling simulation approaches to predict and estimate CO_2 injectivity, plume areal extent, mobility, and fate within the target formation will be field-tested, refined, verified, and validated. Site characterization and MMV activities will support these efforts.

- Approaches to predict the effects of CO_2 on the integrity of overlying sealing formations will be verified and validated with field- and laboratory-based data. Testing and modeling of the key geomechanical, geochemical, and hydrogeological parameters of sealing formations that might be affected by large-scale CO_2 injection will support these efforts.
- The presence/absence of leakage pathways in the study area will be definitively addressed. Site characterization and MMV activities will provide the basis for this determination.

- A mitigation strategy for potential future leaks through any identified potential pathways will be developed. The goal of the mitigation strategy will be to develop cost-effective means of achieving a state of near-zero leakage throughout the lifetime of the project.

- Cost-effective, safe, and broadly applicable CO_2 injection well designs and well bore management techniques will be field-tested.

- Risk assessment and management strategies will be examined, evaluated, and applied to ensure large-scale CO_2 injection into oil fields is effective and safe.

- Characterization data will be gathered to verify the ability of the target formations to store CO_2 and meet DOE's goal of verifying capacity that could store 50% of the region's point-source emissions over the next 100 years.

- North America's infrastructure to transport CO_2 from sources to the injection sites will be expanded.

- The regulatory and permitting framework in North America will be advanced.

- A test bed will be provided for developing technologies related to sequestration of anthropogenic CO_2.

- A mechanism will be developed by which carbon credits can be monetized for CO_2 sequestered in geologic formations. Successful implementation of these activities will put the PCOR Partnership region at the forefront of CO_2 sequestration technology and implementation, while adding significant economic value to the region.

Summary of Potential Modeling and MMV Efforts:

Measurement Technique	Measurement Parameters	Application
Static Geological Modeling	Porosity and permeability of formations using well log data, drill stem test data, injection well data, and core analysis data.	Identifying injection zones and seals and quantifying their key characteristics.
Reservoir Simulation Modeling	Porosity, permeability, injectivity, fluid dynamics, using well log DST, injection, production, and core data.	Predict the movement and fate of injected CO_2 and the potential effects on aquifer dynamics.
Geomechanical Modeling	Static-to-dynamic elastic properties.	Predict the geomechanical effects of injection on sinks and seals.
Geochemical Modeling	Reactions between CO_2, H_2S, oil, pore water, and rocks under reservoir conditions.	Predict effects and impact of mineralization in the injection zone on sequestration and injection.
Introduced and Natural Tracers	Travel time Partitioning of CO_2 into brine or oil	Tracing movement of CO_2 in and/or out of the storage formation Quantifying solubility trapping

Measurement Technique	Measurement Parameters	Application
Water Composition	CO_2, HCO_{3-}, CO_3^{2-} Major ions Trace elements Salinity	Quantifying solubility and mineral trapping Quantifying CO_2–water–rock interactions Detecting any leakage into shallow groundwater formations
Well Logs	Brine salinity Sonic velocity CO_2 saturation	Tracking CO_2 movement in and above storage formation Tracking migration of brine into shallow aquifers Calibrating seismic velocities for 3D seismic surveys
Vertical Seismic Profiling and Crosswell Seismic Imaging	P and S wave velocity Reflection horizons Seismic amplitude attenuation	Inferring distribution of CO_2 in the storage formation Visualizing any leakage through faults and fractures
Passive seismic monitoring	Location, magnitude and source characteristics of seismic events	Delineation of microfractures in formation or caprock Delineating potential CO_2 migration pathways

Accomplishments to Date:

The PCOR Partnership was awarded the third phase of the Regional Carbon Sequestration Partnership Program in October 2007. The activities for the Williston Basin demonstration are progressing; Quarter 2 of Budget Period 3 will see such accomplishments as a site geological characterization experimental design package and the finalization of the site locations.

Summarize Target Sink Storage Opportunities and Benefits to the Region:

- The project will result in the establishment of relevant, cost-effective MMV protocols for oil field CCS that can be applied globally.
- Represents the first large-scale CCS project from a retrofitted conventional coal-fired power plant.
- The project will permanently sequester 0.50 to 1.0 Mt of CO_2/year.

Cost:

Total Field Project Cost: $101,247,680

DOE Share: $36,901,015 36%

Non-Doe Share: $64,346,665 64%

Field Project Key Dates: Anticipated to be on schedule with Gantt Chart – see below):

Baseline Completed: Q4 FY 2010

Drilling Operations Begin: Q2 FY 2010

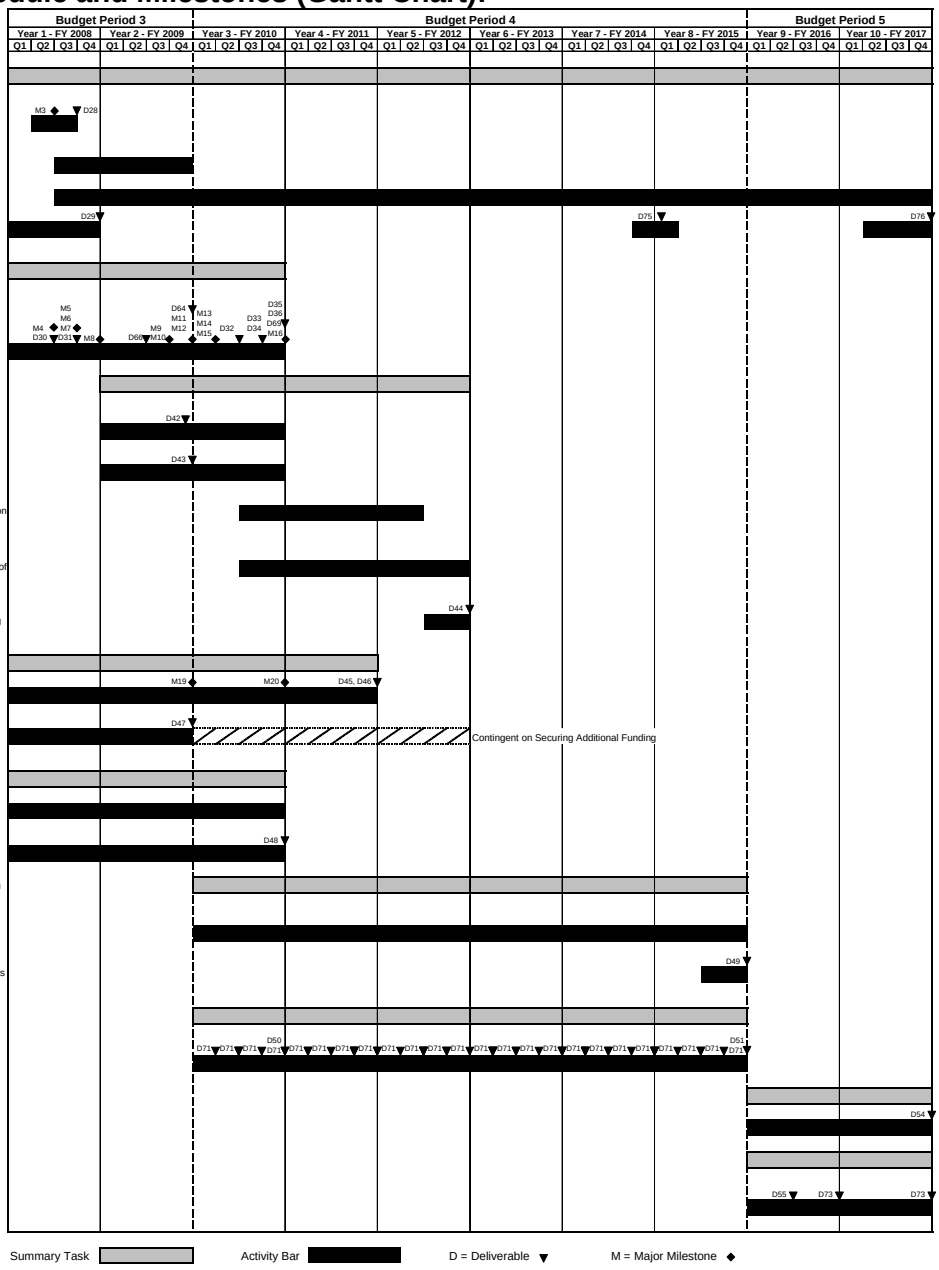
Injection Operations Begin: Q4 FY 2010

MMV Events:

Monitoring Scheme Design Completed – Q4 FY 2009

Site Characterization Modeling and Monitoring Plan Completed – Q4 FY 2010

Field Test Schedule and Milestones (Gantt Chart):



Key for Deliverables

D28 Environmental Questionnaire – Williston Basin Test Site
D29 Permitting Action Plan
D30 Williston Basin Test Site – Geomechanical Experimental Design Package
D31 Experimental Design Package Williston Basin Test Site Geological Characterization
D32 Williston Basin Test Site – Geomechanical Final Report
D33 Williston Basin Test Site – Geochemical Final Report
D34 Williston Basin Test Site – Baseline Hydrogeological Final Report
D35 Williston Basin Test Site – Best Practices Manual - Site Characterization
D36 Williston Basin Test Site – Wellbore Leakage Final Report
D42 Williston Basin Test Site – Injection Experimental Design Package
D43 Williston Basin Test Site – Monitoring Experimental Design Package
D44 Williston Basin Test Site – Drilling and Completion Activities Final Report
D45 Topical Report on the Integrated Capture Plant and its Shakedown
D46 Topical Report on Pipeline Route Selection, Design, and Construction
D47 Topical Report on the Preliminary Design of Advanced Compression Technology
D48 Procurement Plan and Agreement Report
D49 Transportation and Injection Operations Final Report
D50 Williston Basin Test Site – Site Characterization, Modeling, and Monitoring Plan
D51 Williston Basin Test Site – Monitoring for CO_2, EOR, and Sequestration Best Practices Manual
D54 Site Closure Report
D55 Report on Cost-Effective Long-Term Monitoring Strategies for the Williston Basin Test Site
D64 Williston Basin Test Site – Site Characterization Report
D66 Williston Basin Test Site – Simulation Report
D69 Williston Basin Test Site – Best Practices Manual – Simulation Report
D71 Williston Basin Test Site – Quarterly Summary of Operations
D73 Williston Basin Test Site – Progress Report on Monitoring and Modeling Fate of CO_2
D75 Updated Permitting Action Plan
D76 Best Practices Manual - Permitting

Key for Milestones

M3 Start Environmental Questionnaire for Williston Basin Test Site
M4 Williston Basin Test Site Selected
M5 Data Collection Initiated for Williston Basin Test Site
M6 Williston Basin Test Site Geochemical Work Initiated
M7 Williston Basin Test Site Geological Characterization Data Collection Initiated
M8 Williston Basin Test Site Wellbore Leakage Data Collection Initiated
M9 Williston Basin Test Site B-Version Geological Model Development Initiated
M10 Williston Basin Test Site Wellbore Leakage Data Collection Completed
M11 Williston Basin Test Site Baseline Hydro Data Collection Completed
M12 Williston Basin Test Site Geochemical Work Completed
M13 Williston Basin Test Site B-Version Geological Model Development Completed
M14 Williston Basin Test Site Geological Characterization Data Collection Completed
M15 Williston Basin Test Site Baseline Hydro B-Model Completed
M16 Williston Basin Test Site Final Geological Model Development Completed
M19 Capture, Dehydration, and Compression Technology Selected
M20 Capture, Dehydration, and Compression Technology Design Completed

Additional Information

Because this project is part of an EOR project, it can be assumed that all appropriate rights have been attributed to the partners of the project. EOR activities will have gone through the unitization process; therefore, requisite rights for injection will have been acquired. The unitization process has been completed in accordance with the North Dakota Century Code and corresponding rules contained in the North Dakota Administrative Code.

The volume of incremental oil that could be produced from Williston Basin oil fields has been estimated to be approximately 1 billion barrels. Using a recent price for Williston Basin oil of $67/bbl, the value of the incremental oil is nearly $67 billion. From a CO_2 source perspective, the ongoing EOR projects at the Weyburn and Midale oil fields in Saskatchewan have established a preliminary value for CO_2 in the Williston Basin of approximately $1 per Mcf (approximately $17 to $18 per ton). Phase I results indicate that several hundred million tons of CO_2 are needed to produce the incremental oil. The magnitude of this financial opportunity for the development of a CO_2 market in the Williston Basin has attracted the attention of many oil field operators and the owners of large stationary CO_2 sources in the region, including coal-fired power plants. Many of these companies are members of the PCOR Partnership (Phase I and Phase II) and have expressed strong support for a Phase III project focused on EOR in the Williston Basin. Based largely on input from the members of the PCOR Partnership and the tremendous value-added product that can be derived from CO_2-based EOR, the PCOR Partnership is compelled to focus the bulk of its Phase III efforts on demonstrating the viability of CO_2 sequestration in conjunction with EOR operations.