FACTSHEET FOR PARTNERSHIP FIELD VALIDATION TEST

Partnership Name	Plains CO_2 Reduction (PCOR) Partnership – Phase II	
Contacts:	Name Organization E-Mail	
DOE/NETL Project Mgr.	Darin Damiani, U.S. Department of Energy, Darin.Damiani@netl.doe.gov	
Principal Investigator	Edward Steadman	
Field Test Information: Field Test Name	PCOR Terrestrial Field Validation Test	
Test Location	North Dakota, South Dakota, Minnesota, Montana, Iowa	
Amount and Source of CO_2	Tons N/A	Source Atmospheric CO_2
Field Test Partners (Primary Sponsors)	Ducks Unlimited, Inc.	
	U.S. Geological Survey Northern Prairie Wildlife Research Center	
	North Dakota State University	

Summary of Field Test Site and Operations:

Presently, there is insufficient information on aboveground and belowground carbon being sequestered in restored wetlands and grasslands of the Prairie Pothole Region (PPR). The PCOR Partnership is quantifying the amount of carbon being sequestered in restored grasslands and will provide a standardized estimate of carbon sequestered under various grassland management regimes throughout the project area. Multiple covariates—including the age of the restored grassland, soil productivity class, and current land management—will be used to model carbon sequestration rates in restored grasslands, native prairie, and cropland. These rates will be determined for lands with varied land use, including restored grassland and wetland complexes on one or more properties in the PPR. This research will also determine an upper bound to soil organic carbon (SOC) levels expected from grassland under most common land management practices (i.e., pasture, haying). A review will be conducted on the impacts that cattle grazing and emergency haying have on greenhouse gas (GHG) fluctuations. This is vital to the economic feasibility of a carbon offset market in this region.

The PCOR Partnership will also determine carbon sequestration rates and GHG flux in wetlands and adjacent grasslands. GHG flux will be measured at various landscape positions within wetland basins and their surrounding upland catchments. The effort will also monitor carbon sequestration and GHG flux on other property-monitoring sites through time to better assess the effects on GHG emissions by controlling for spatial heterogeneity.

Research Objectives:

The objective of the terrestrial field validation is to develop the technical capacity to systematically identify, develop, and apply alternate land use management practices to the prairie pothole ecosystem (at both a local and regional scale) that will result in carbon sequestration and the monetization of carbon offsets. These reductions will include emission offsets achieved by defining best management practices (BMPs) for sequestering carbon and reducing GHGs in restored wetland/grassland complexes. The field validation includes assessments of both the socioeconomic and physical/chemical environment.

Summary of Modeling and MMV Efforts: (Use the table provided for MMV)

Measurement Technique	Measurement Parameters	Application
Static Chamber Approach	Measurement of fluxes of nitrous oxide (N_2O), methane (CH_4), and carbon dioxide (CO_2)	Gas exchange measurements
Various Meters/Probes and Laboratory Sampling Techniques	Volumetric water content (θ), total soil porosity (P_t), soil temperature, precipitation, and climate and soil properties	To determine influences on gas flux and carbon storage
Core Sampling (soil probe)	Soil bulk density, soil moisture, and soil analysis for carbon	Measurement of carbon in soil

Accomplishments to Date:

- Completed experimental design package, Health and Safety Plan, National Environmental Policy Act compliance document and Regulatory Permitting Action Plan, Outreach Action Plan, and Sampling Protocol Plan.
- PPR terrestrial field validation test sites were selected and instrumented for sampling.
- Gas emissions have been collected from 17 wetlands in north-central South Dakota (7000 individual gas flux samples collected).
- Soil samples have been collected on 8770 acres of native grassland, restored grassland, and cropland to date (1458 soil sampled collected) from North and South Dakota and Minnesota sites.
- Business model/processes for aggregating and transacting carbon offsets in a voluntary market is complete. Legal documents for easements (including carbon rights) are complete. PCOR partners are currently enrolling landowners into a terrestrial Carbon Credit Program.
- Synthesis of research relating to BMPs that result in GHG reductions is ongoing. Existing PCOR Partnership BMP *Fact Sheet* will be updated as results are available.
- Ongoing evaluation of Department of Energy Technical Guidelines, particularly as they relate to grassland sequestration, aggregator roles, and criteria for additionality, leakage, and permanence.
- Database tools for tracking offset portfolios and transacted offsets have been developed. Database includes business requirements generated for calculating, inventorying, and tracking offsets.

Summarize Target Sink Storage Opportunities and Benefits to the Region:

Areas targeted for the terrestrial field validation test include grasslands (native and restored) and wetlands (native, restored, and cropland) throughout the PPR. These areas, when properly managed and/or restored, offer significant immediate storage opportunities.

Landowners in the PPR can benefit financially by payments received for conveying carbon rights through carbon credit programs. These payments would be in addition to traditional farm program or easement payments. The public sector will benefit by use and nonuse values of wetland/grassland areas as they pertain to recreational activities (e.g., hunting, fishing, and bird watching) and other cobenefits such as flood attenuation, water quality, groundwater recharge, sediment loading, and erosion reduction.

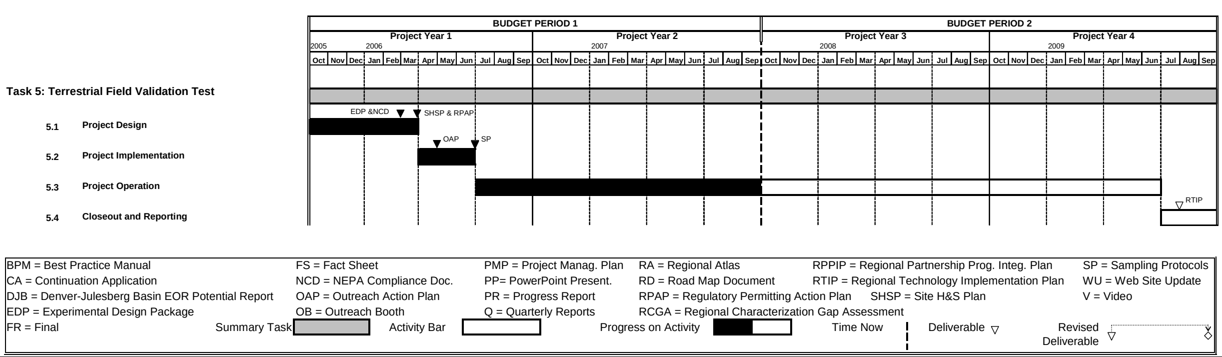
In addition to the physical/chemical validation tests, the PCOR Partnership will determine the sociological and economic feasibility of terrestrial sequestration offsets. A Web-based landowner outreach strategy will be developed and materials will be prepared and disseminated to solicit participation in a carbon sequestration program. Outreach activities to inform the public and other potential partners about the project will be performed. Economic feasibility will be assessed based on research to determine price points for terrestrial sequestration and by modeling economic feasibility when carbon is included in the financial portfolio of a typical landowner. Spatial models will be developed that integrate the physical/chemical capabilities to sequester carbon with the socioeconomic and willingness-to-participate information gleaned from other facets of the validation test. This will result in maps and other spatial products that portray where carbon could be sequestered most cost-effectively in the project area.

Cost:	**Field Project Key Dates:**
Total Field Project Cost: $3,204,358	**Baseline Completed: See Gantt Chart below**
DOE Share: $ 2,634,988 82%	**Drilling Operations Begin: NA**
Non-Doe Share: $569,370 18%	**Injection Operations Begin: NA**
	MMV Events: See Gantt Chart below

Field Test Schedule and Milestones (Gantt Chart):

Terrestrial field test project operations will track the following statement of work:

- Experimental design package and National Environmental Policy Act Compliance document due February 28, 2006 – completed on schedule
- Site Health and Safety Plan due March 31, 2006 – completed on schedule
- Regulatory Permitting Action Plan due March 31, 2006 – completed on schedule
- Outreach Action Plan due April 30, 2006 – completed on schedule
- Sampling protocols due June 30, 2006 – completed on schedule
- Regional Technology Implementation Plan due July 31, 2009



Additional Information

Measurement of Gas Fluxes

Fluxes of nitrous oxide (N_2O), methane (CH_4), and carbon dioxide (CO_2) are being measured on a biweekly basis during the growing season (approximately May–September) using a static (non-steady state) chamber approach (Livingston and Hutchinson, 1995). In each catchment, eight (five wetland and three upland) monitoring locations have been established along a transect extending from the wetland center to catchment boundary. Five monitoring locations have been established in the wetland zone by placing one chamber in the wetland center, one in the wetland–upland transition zone, and three at equal-distance intervals between the wetland center and wetland–upland transition zone. Monitoring locations have been established in the upland zone by placing a chamber in the center of each of the three landscape positions, the toeslope, midslope, and should (or shoulder) slope. The placement of eight chambers along transects covers a range of soil moisture conditions (i.e., soil water-filled pore space [WFPS]) that influences emission of gases; studies suggest that the relative contribution of nitrification and denitrification to N_2O and dinitrogen (N_2) emissions varies with WFPS (Davidson et al., 2000). We expect WFPS to range from field capacity (60% WFPS) at the wetland–upland transition zone to saturated (100%) near the wetland center. Changes in WFPS along transects are expected to be gradual rather than abrupt because of low relief associated with depressional wetlands. Hence, soil moisture is not expected to vary more than 10% (e.g., 60%, 70%, 80%, 90%, 100%) between chambers along transects. However, more gas chambers will be added along each transect depending upon variation, e.g., if we encounter abrupt changes in WFPS along transects among and within wetlands (see below for measurement of WFPS).

To start gas flux measurements, chambers are sealed to the chamber bases at dry sites, and floating chambers will be deployed at wet sites. Gases are allowed to accumulate in the chamber headspace for a minimum of 30 minutes after deployment. Headspace gas samples are withdrawn from the chamber through a septum port by syringe. Samples of the initial gas concentration are obtained by drawing ambient atmosphere into a syringe at the start of the flux measurement. All syringe gas samples are immediately transferred to and stored overpressurized in 10-mL preevacuated (<10 torr) crimp-top serum bottles fitted with thick gas-impermeable septa/stoppers. Laboratory tests have shown that N_2O, CH_4, and CO_2 concentrations remain stable within the overpressurized serum bottles for at least 3 weeks (University of Wisconsin – Stevens Point [UWSP] Dissolved Gas Laboratory).

Gas samples are analyzed by gas chromatography within 1 week of sampling. A gas chromatograph (SRI Model 8610) equipped with electron capture (ECD) and flame ionization (FID) detectors and two 10-port valves is being used to measure N_2O, CH_4, and CO_2 with a single injection of sample. The instrument configuration and operating conditions (modified from Coolman and Robarge [1995] and Lotfield et al. [1997]) provide minimum detection levels of <3 ppbv N_2O (ECD), <10 ppbv CH_4 (FID), and <1 ppmv CO_2 (ECD and FID). Coefficients of variation for detection of the three target gases within ambient air are less than 2% (UWSP Dissolved Gas Laboratory). The gas chromatograph has been calibrated with commercial N_2O, CH_4, and CO_2 air blends verified against a reference standard from the National Oceanic and Atmospheric Administration.

Measurement of Covariables Known to Influence Gas Fluxes

Water-Filled Pore Space: Along a moisture gradient from the upland zone to the center of each wetland, WFPS is expected to exert important control over trace gas production in the soil (Davidson et al., 2000). The formation of N_2O as a by-product of nitrification and denitrification reactions peaks at about 60% WFPS (Davidson et al., 2000). Below 60% WFPS, NO (nitric oxide) becomes an increasingly dominant gaseous by-product of nitrification relative to N_2O, while above 80%, N_2O tends to be converted to N_2 gas. The formation of CH_4 as a product of anaerobic soil respiration becomes increasingly favored as WFPS approaches 100%. Soil WFPS is expressed as the ratio of volumetric water content (θ) and total soil porosity (P_t):

$$\%WFPS = (\theta/P_t) \bullet 100$$

During each biweekly sampling event, θ is measured in the top 15 cm of the soil near each gas chamber along each transect using a TH_2O soil moisture meter. Total porosity (P_t) in the top 15 cm of soil is determined from bulk density (ρ_b) and particle density (ρ_s) according to:

$$P_t = 1 - \rho_b/\rho_s$$

Soil densities are mapped on a one-time basis along each transect using the core (ρ_b) and pycnometer (ρ_s) methods (Klute, 1986), respectively. Soil densities are assumed to be constant during the study period.

Soil Temperature: Microbially mediated nitrification and denitrification processes are influenced by soil temperature (Paul and Clark, 1996). During each biweekly sampling event, temperature (°C) is measured in the top 15 cm of the soil near each gas chamber along each transect using a soil thermometer. Additionally, temperature data loggers are buried in the center of each wetland to provide a continuous (e.g., hourly) record of soil temperature fluctuations.

Precipitation and Climate: A rain gauge will be installed at each wetland. Precipitation will be monitored weekly and after major or unusual precipitation events.

Soil Properties: Soil samples are collected to a depth of 15 cm near monitoring locations and submitted for determination of the following: extractable nitrate (NO_3) and ammonium (NH_4), total nitrogen, total carbon, organic carbon, inorganic carbon, extractable phosphorus (P), bulk density (g/cm^3), and soil texture. Methods of determination follow those described by Page et al. (1982) and Klute (1986).

Wetland and Catchment Morphometry Information: Nutrient loading and groundwater flows are influenced by catchment morphometry. A topographic field survey will be conducted on all catchments. Wetland catchments are surveyed using a global positioning system total station (Trimble, 5700). Using the program ForeSight version 1.3 (Tripod Data Systems, Inc., Corvallis, Oregon), estimations of wetland and upland areas (ha), maximum depth (m), and wetland volume (ha-m). Additionally, the average grade (%) and length (m) of the upland slopes are being estimated.

Statistical Analysis

The analysis of covariance with repeated measures (Milliken and Johnson, 2002) is being employed to test for differences in gas emissions ($mass \cdot area^{-1} \cdot time^{-1}$) with respect to land use treatment (i.e., farmed, restored, and native prairie wetlands) while controlling for covariates (e.g., WFPS, temperature).

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