ANNUAL ASSESSMENT REPORT

Plains CO_2 Reduction (PCOR) Partnership Phase III
Task 12 – Deliverable D57

(for the period October 1, 2009, through September 30, 2010)

Prepared for:

Andrea T. McNemar

U.S. Department of Energy
National Energy Technology Laboratory
3610 Collins Ferry Road
PO Box 880, M/S P03D
Morgantown, WV 26507-0880

Cooperative Agreement No. DE-FC26-05NT42592

Prepared by:

Edward N. Steadman
John A. Harju
Lucia Romuld
James A. Sorensen
Daniel J. Daly
Charles D. Gorecki
Steven A. Smith
Melanie D. Jensen
Lisa S. Botnen
Wesley D. Peck
Katherine K. Anagnost
Tami Jo Votava

Energy & Environmental Research Center
University of North Dakota
15 North 23rd Street, Stop 9018
Grand Forks, ND 58202-9018

2011-EERC-02-02

December 2010
Approved

DOE DISCLAIMER

EERC DISCLAIMER

TABLE OF CONTENTS

Continued…

TABLE OF CONTENTS, continued

LIST OF FIGURES

Continued…

LIST OF FIGURES, continued

LIST OF TABLES

ANNUAL ASSESSMENT REPORT

Edward N. Steadman, Energy & Environmental Research Center
John A. Harju, Energy & Environmental Research Center
Lucia Romuld, Energy & Environmental Research Center
James A. Sorensen, Energy & Environmental Research Center
Daniel J. Daly, Energy & Environmental Research Center
Charles D. Gorecki, Energy & Environmental Research Center
Steven A. Smith, Energy & Environmental Research Center
Melanie D. Jensen, Energy & Environmental Research Center
Lisa S. Botnen, Energy & Environmental Research Center
Wesley D. Peck, Energy & Environmental Research Center
Katherine K. Anagnost, Energy & Environmental Research Center
Tami Jo Votava, Energy & Environmental Research Center

December 2010

EXECUTIVE SUMMARY

The Plains CO_2 Reduction (PCOR) Partnership is one of seven Regional Carbon Sequestration Partnerships (RCSPs) competitively awarded by the U.S. Department of Energy National Energy Technology Laboratory in 2003 as part of a national plan to mitigate greenhouse gas emissions. The PCOR Partnership is led by the Energy & Environmental Research Center (EERC) at the University of North Dakota in Grand Forks, North Dakota, and includes nearly 90 stakeholders from the public and private sector in Phase III. The PCOR Partnership region includes all or part of nine U.S. states and four Canadian provinces.

Phase III, the development phase, a 10-year effort (2007–2017), is an extension of the characterization (Phase I) and validation (Phase II) phases and is intended to demonstrate that carbon dioxide (CO_2) capture, storage, and transportation can be achieved safely, permanently, and economically at a large scale in the PCOR Partnership region.

The Phase III efforts of the PCOR Partnership include two large-volume demonstration tests that focus on injecting CO_2 into deep geologic formations for CO_2 storage. The Fort Nelson demonstration involves monitoring, verification, and accounting (MVA) support for the injection of CO_2 captured from one of the largest gas-processing plants in North America into a saline formation in British Columbia, Canada. The Bell Creek demonstration involves injection of CO_2 into formations in the Powder River Basin in the northern Great Plains region of North America for the dual purpose of CO_2 storage and enhanced oil recovery (EOR). Other activities in Phase III include the following: 1) continue to gather regional characterization data to verify the ability of the target formations to store CO_2, 2) facilitate the development of the infrastructure

required to transport CO_2 from sources to the injection sites, 3) facilitate development of the rapidly evolving North American regulatory and permitting framework, 4) develop opportunities for PCOR Partnership partners to capture and store CO_2, 5) establish a technical framework by which carbon credits can be monetized for CO_2 stored in geologic formations, 6) continue collaboration with other RCSPs, and 7) provide outreach and education for CO_2 capture and storage stakeholders and the general public.

Budget Period 4 (Program Years 3–8 of Phase III) began October 1, 2009. Significant effort was focused in Program Year 3 (October 1, 2009 – September 30, 2010) on facilitating the development of a CO_2 procurement plan and agreement for the Bell Creek demonstration. The site was selected, information was being exchanged, and project discussions were under way with long-time partner, Encore Acquisition Company (Encore), the owner/operator of the Bell Creek oil field site. Then, in October 2009, a merger agreement was announced between Encore and Denbury Resources Inc. (Denbury). The merger was approved in March 2010, and postacquisition integration activities unrelated to the Bell creek project, understandably, were Denbury's primary focus. PCOR Partnership efforts continued throughout the summer to establish ongoing communication with the Denbury transition management team, a team largely unfamiliar with the PCOR Partnership. These efforts culminated in September 2010 with an invitation to visit Denbury's headquarters in Plano, Texas. It now appears that negotiations are back on track and the PCOR Partnership is optimistic that its ability to add value to the Denbury operations will propel the Bell Creek demonstration forward.

Activities for the Fort Nelson demonstration project are progressing. In early January 2010, the site owner/operator, Spectra Energy, completed a "slant drill" operation off the well that was drilled last year. This provided an opportunity for a variety of new tests (well logging, leakoff tests, and water injection tests) to further understand the injection target. Predictive simulation modeling and laboratory experiments on core and cap rock cuttings are ongoing. The EERC staff continued to meet regularly with representatives of Spectra Energy to discuss the direction and progress of baseline characterization, modeling, and MVA plan development for the project. In addition, the Fort Nelson CCS Project received formal recognition from the Carbon Sequestration Leadership Forum at its London 2009 meeting as a collaborative research project focused on the development of cost-effective technologies required to initiate widespread carbon capture and to conduct safe, secure long-term geologic storage.

All other tasks also continued to effectively support program goals. Regional characterization continues, capture technologies are under review, relationships with regional regulators grow stronger, and new outreach products (documentaries and atlases) are being created.

Activities that will lead to the initiation of CO_2 injection in both demonstration sites will continue during Program Year 4 (2010–2011). Operational monitoring and modeling activities will continue to be performed to verify that injection operations do not adversely impact human health or the environment and that the CO_2 injected has been safely stored, with minimal risk of natural release. All other support tasks will also continue to be implemented.

This report presents an update of Phase III PCOR Partnership activities from October 1, 2009, through September 30, 2010, and planned activities for the following year.

ANNUAL ASSESSMENT REPORT

Edward N. Steadman, Energy & Environmental Research Center
John A. Harju, Energy & Environmental Research Center
Lucia Romuld, Energy & Environmental Research Center
James A. Sorensen, Energy & Environmental Research Center
Daniel J. Daly, Energy & Environmental Research Center
Charles D. Gorecki, Energy & Environmental Research Center
Steven A. Smith, Energy & Environmental Research Center
Melanie D. Jensen, Energy & Environmental Research Center
Lisa S. Botnen, Energy & Environmental Research Center
Wesley D. Peck, Energy & Environmental Research Center
Katherine K. Anagnost, Energy & Environmental Research Center
Tami Jo Votava, Energy & Environmental Research Center

December 2010

INTRODUCTION

The Plains CO_2 Reduction (PCOR) Partnership is one of seven regional partnerships operating under the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) Regional Carbon Sequestration Partnership (RCSP) Program. The PCOR Partnership is led by the Energy & Environmental Research Center (EERC) at the University of North Dakota in Grand Forks, North Dakota, and includes nearly 90 stakeholders from the public and private sector in Phase III. The Phase III membership as of September 30, 2010, is listed in Table 1. The PCOR Partnership region includes all or part of nine states (Iowa, Minnesota, Missouri, Montana, Nebraska, North Dakota, South Dakota, Wisconsin, and Wyoming) and four Canadian provinces (Alberta, British Columbia, Manitoba, and Saskatchewan).

The RCSP Program comprises a large portion of NETL's Carbon Sequestration Program and is a government–industry effort tasked with determining the most suitable technologies, regulations, and infrastructure needs for carbon capture and storage (CCS) on the North American continent.

The RCSP Program initiative is being implemented in three phases:

- Phase I – Characterization Phase (2003–2005): characterized opportunities for carbon sequestration.

Table 1. PCOR Partnership III Partners*

1) U.S. Department of Energy National Energy Technology Laboratory
2) University of North Dakota Energy & Environmental Research Center
3) Abengoa Bioenergy New Technologies
4) Air Products and Chemicals
5) Alberta Department of Energy
6) Alberta Research Council
7) ALLETE
8) Ameren Corporation
9) American Coalition for Clean Coal Electricity
10) American Lignite Energy (ALE)
11) Aquistore
12) Apache Canada Ltd.
13) Baker Hughes Oilfield Operations, Inc.
14) Basin Electric Power Cooperative
15) Biorecro AB
16) Blue Source, LLC
17) BNI Coal, Ltd.
18) British Columbia Ministry of Energy, Mines and Petroleum Resources
19) British Columbia Oil and Gas Commission
20) Carbozyme, Inc.
21) Computer Modelling Group, Inc.
22) Dakota Gasification Company
23) Ducks Unlimited Canada
24) Ducks Unlimited, Inc.
25) Eagle Operating, Inc.
26) Eastern Iowa Community College District
27) Enbridge Inc.
28) Encore Acquisition Company
29) Energy Resources Conservation Board/Alberta Geological Survey
30) Environment Canada
31) Excelsior Energy Inc.
32) Fischer Oil and Gas, Inc.
33) Great Northern Project Development, LP
34) Great River Energy
35) Hess Corporation
36) Huntsman Corporation
37) Interstate Oil and Gas Compact Commission
38) Iowa Department of Natural Resources – Geological Survey
39) Lignite Energy Council
40) Manitoba Geological Survey
41) Marathon Oil Company
42) MEG Energy Corporation
43) Melzer Consulting
44) Minnesota Power
45) Minnkota Power Cooperative, Inc.
46) Missouri Department of Natural Resources

* Phase II members in good standing were automatically enrolled in Phase III for overlapping years (October 1, 2007 – September 30, 2009).

Continued . . .

Table 1. PCOR Partnership III Partners* (continued)

47) Missouri River Energy Services
48) Montana–Dakota Utilities Co.
49) Montana Department of Environmental Quality
50) National Commission on Energy Policy
51) Natural Resources Canada
52) Nebraska Public Power District
53) Nexant, Inc.
54) North American Coal Corporation
55) North Dakota Department of Commerce Division of Community Services
56) North Dakota Department of Health
57) North Dakota Geological Survey
58) North Dakota Industrial Commission Department of Mineral Resources, Oil and Gas Division
59) North Dakota Industrial Commission Lignite Research, Development and Marketing Program
60) North Dakota Industrial Commission Oil and Gas Research Council
61) North Dakota Natural Resources Trust
62) North Dakota Petroleum Council
63) North Dakota Pipeline Authority
64) North Dakota State University
65) Otter Tail Power Company
66) Oxand Risk & Project Management Solutions
67) Petroleum Technology Research Centre
68) Petroleum Technology Transfer Council
69) Prairie Public Broadcasting
70) Pratt & Whitney Rocketdyne, Inc.
71) Ramgen Power Systems, Inc.
72) RPS Energy Canada Ltd.
73) Saskatchewan Industry and Resources
74) SaskPower
75) Schlumberger
76) Shell Canada Energy
77) Spectra Energy
78) Strategic West Energy Ltd.
79) Suncor Energy Inc.
80) TAQA NORTH, Ltd.
81) TGS Geological Products and Services
82) University of Alberta
83) U.S. Geological Survey Northern Prairie Wildlife Research Center
84) Weatherford Advanced Geotechnology
85) Western Governors' Association
86) Westmoreland Coal Company
87) Wisconsin Department of Agriculture, Trade and Consumer Protection
88) Wyoming Office of State Lands and Investments
89) Xcel Energy

* Phase II members in good standing were automatically enrolled in Phase III for overlapping years (October 1, 2007 – September 30, 2009).

- Phase II – Validation Phase (2005–2009): conducted small-scale field validation tests.
- Phase III – Development Phase (2007–2017): conducting large-volume carbon storage demonstration tests (Figure 1).

The PCOR Partnership's efforts are in support of the following NETL Carbon Sequestration Program goal:

"*By 2012, develop fossil fuel conversion systems that offer 90% CO_2 capture with 99% storage permanence at less than a 10% increase in the cost of energy services*" (1).

Attainment of this program goal will be aided by the PCOR Partnership's integrated approach to address identified challenges. The PCOR Partnership's efforts will help enable technologies to overcome a multitude of economic, social, and technical challenges, including cost-effective carbon dioxide (CO_2) capture through successful integration with fossil fuel conversion systems, effective CO_2 monitoring and verification, permanence of underground CO_2 storage, and public acceptance.

The PCOR Partnership was established in the fall of 2003. Phase I was focused on characterizing sequestration opportunities in the region. In the fall of 2005, the PCOR Partnership launched its 4-year, Phase II program focused on carbon storage field validation projects. These Phase II projects were designed to build core local technical expertise and experience needed to facilitate future large-scale CO_2 sequestration efforts in the region's subsurface and terrestrial settings. In the fall of 2007, the PCOR Partnership initiated its 10-year Phase III program focused on implementing two commercial-scale geologic carbon sequestration demonstration projects in the region.

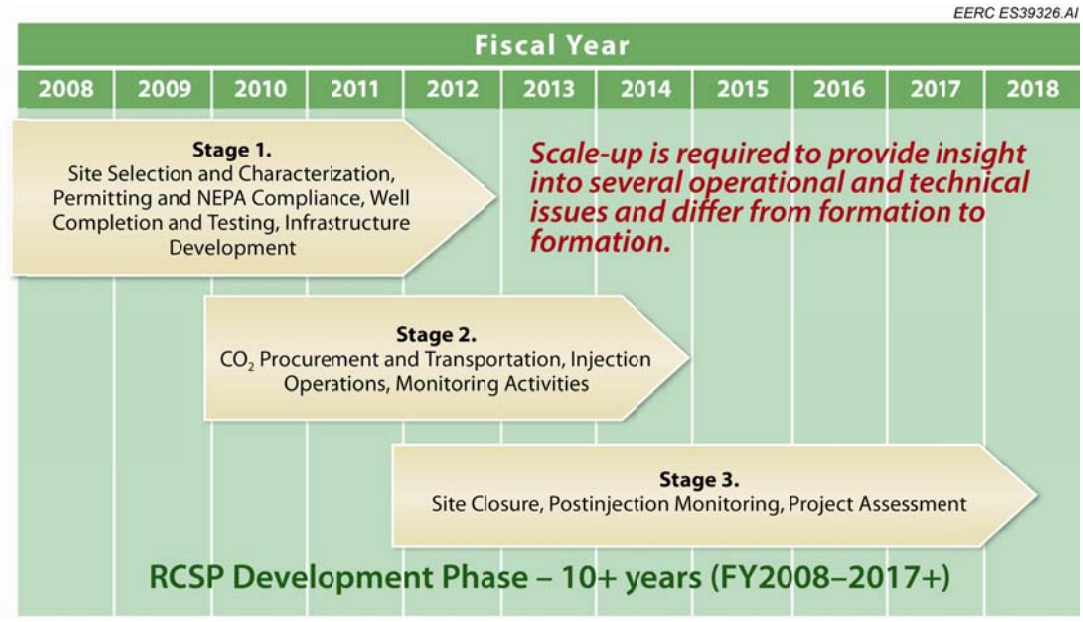


Figure 1. RCSP development phase: scaling up toward commercialization (figure taken from DOE NETL).

Phase III is divided into three budget periods (BPs), running from October 1, 2007, to September 30, 2017:

Budget Period 3 (BP3): October 1, 2007 – September 30, 2009
Budget Period 4 (BP4): October 1, 2009 – September 30, 2015
Budget Period 5 (BP5): October 1, 2015 – September 30, 2017
Note: BP1 and BP2 were effective in Phase II.

The overall mission of the Phase III program is to 1) gather characterization data to verify the ability of the target formations to store CO_2, 2) facilitate the development of the infrastructure required to transport CO_2 from sources to the injection sites, 3) facilitate development of the rapidly evolving North American regulatory and permitting framework, 4) develop opportunities for PCOR Partnership partners to capture and store CO_2, 5) establish a technical framework by which carbon credits can be monetized for CO_2 stored in geologic formations, 6) continue collaboration with other RCSPs, and 7) provide outreach and education for CO_2 capture and storage stakeholders and the general public.

In Phase III, the PCOR Partnership is building on the information generated in its characterization (Phase I) and validation (Phase II) phases. The PCOR Partnership plans to fully utilize the infrastructure of its region to maximize CO_2 injection volumes. A programmatic RCSP Phase III goal is the injection of approximately 1 million tons of CO_2 a year into at least one regionally significant geologic formation. Each of the RCSP's large-volume injection tests is designed to demonstrate that the CO_2 storage sites have the potential to store regional CO_2 emissions safely, permanently, and economically for hundreds of years.

The PCOR Partnership is working toward the establishment of two demonstration sites. The sites are located in 1) the Bell Creek oil field in Powder River County, southeastern Montana, and 2) near Spectra Energy's Fort Nelson gas-processing facility, situated near Fort Nelson, British Columbia, Canada (Figure 2).

Original plans were for a demonstration site project located in the Williston Basin, a large sedimentary basin lying within the PCOR Partnership region, located in eastern Montana, western North and South Dakota, and southern Saskatchewan and Manitoba. The results of Phase I and II activities indicated that this basin has the potential for hosting world-class CO_2 sequestration projects. Unfortunately, negotiations for a site and CO_2 supply within the Williston Basin reached a stalemate in the spring of 2009.

PCOR Partnership management realized that there is substantial interest in the development of a commercial CO_2 storage–enhanced oil recovery (EOR) project and that there are numerous oil-bearing horizons within its region. Therefore, the PCOR Partnership worked diligently to pursue alternative site options.

One such alternative was proposed by a PCOR Partnership partner, namely, Encore Acquisition Company (Encore). Encore proposed to carry out the injection process, while the EERC would conduct CO_2 monitoring, verification, and accounting (MVA) activities at the site. The project, to be conducted in the Bell Creek oil field in Powder River County, southeastern

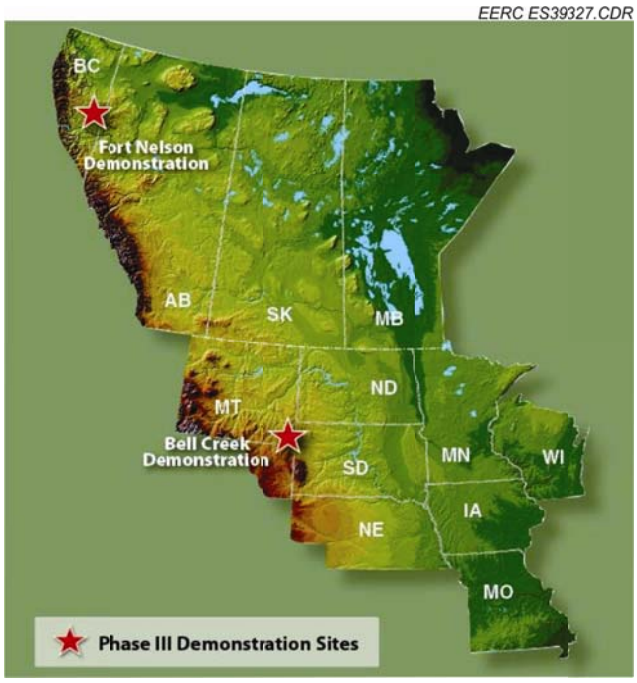


Figure 2. PCOR Partnership Phase III demonstration sites.

Montana, would provide a superb opportunity to develop a set of cost-effective MVA protocols for large-scale CO_2 storage associated with an EOR operation. Although this site is not in the originally targeted Williston Basin, the Bell Creek project is located in the Powder River Basin (PRB), which is geologically similar to the Williston Basin, both tectonically and lithologically, and is located immediately to the southwest of the Williston Basin. The CO_2 source pipeline will run through the PRB of Wyoming and Montana and to within 120 miles of the Cedar Creek Anticline (CCA) in the Williston Basin. The CCA has over 3 billion barrels of original oil in place, with a tertiary target of over 300 million barrels, and is located in Montana, North Dakota, and South Dakota. The selection of the Bell Creek demonstration site is considered a stepping stone to the CCA and was approved by DOE NETL.

Negotiations were well under way to formalize an agreement with Encore, when, on October 31, 2009, Encore and Denbury Resources Inc. (Denbury) entered into a definitive agreement providing for the merger of Encore with and into Denbury. All Encore resources were subsequently redirected to the acquisition, thereby delaying the Bell Creek demonstration site negotiations. On March 9, 2010, the merger was approved, and the combined company, known as Denbury Resources Inc., would be headquartered in Plano, Texas (note: Encore was headquartered in Fort Worth, Texas). All Denbury resources were subsequently redirected to postacquisition integration, and the transitional management team formed was largely unfamiliar with the PCOR Partnership's activities, thereby further delaying negotiations. Throughout the summer, informal discussions between the EERC and Denbury continued, and a nondisclosure agreement was prepared. In September 2010, an invitation to present on October 13, 2010, at Denbury's headquarters was received. One year after the Bell Creek site was selected, most

postacquisition integration activities have now occured, and it appears that negotiations for a formal commitment to work together on the Bell Creek project are back on track.

In collaboration with Spectra Energy, the PCOR Partnership is pursuing a large-scale integrated CCS project near Spectra Energy's existing Fort Nelson natural gas-processing facility in northeast British Columbia, Canada. The Fort Nelson facility is one of the largest sour gas-processing plants in North America. This plant processes gas from an extensive network of approximately 620 miles of gathering pipelines servicing the Horn River producing basin. The sour CO_2 (approximately 90% CO_2 and 10% H_2S) developed by this process will be pipelined a short distance to a storage site. The PCOR Partnership's MVA efforts will help Spectra Energy determine whether deep underground saline reservoirs and associated infrastructure in the Fort Nelson area are appropriate for CCS.

During BP4, Program Year (PY) 3, Spectra Energy, completed a "slant drill" operation off the well that was drilled the previous year. This provided an opportunity for a variety of new tests (well logging, leakoff tests, and water injection tests) to further understand the injection target. In addition, further groundwater well samples were also collected for baseline monitoring. Iterative predictive simulation modeling continued as well as laboratory experiments on the effects of CO_2 and H_2S on core and cap rock cuttings as part of a series of geomechanical and geochemistry experimental activities.

The PCOR Partnership's objectives for the demonstration projects are as follows: 1) conduct a successful Bell Creek demonstration to verify that the region's large number of oil fields have the potential to store significant quantities of CO_2 in a safe, economical, and environmentally responsible manner and 2) conduct a successful Fort Nelson demonstration to verify the economic feasibility of using the region's carbonate saline formations for safe, long-term CO_2 storage. During Phase III, the PCOR Partnership will continue to refine storage resource estimates and evaluate other factors relevant to regional storage goals.

APPROACH

The PCOR Partnership is identifying practical CO_2 sequestration options for the PCOR Partnership region, characterizing the technical issues, enhancing the public's understanding of CO_2 sequestration, identifying the most promising opportunities for sequestration in the region, and detailing an action plan for the demonstration of regional CO_2 sequestration opportunities.

The PCOR Partnership plans to achieve its Phase III mission through a series of 14 tasks, as shown in Figure 3. These tasks include 1) Regional Characterization, 2) Public Outreach and Education, 3) Permitting and National Environmental Policy Act (NEPA) Compliance, 4) Site Characterization and Modeling, 5) Well Drilling and Completion, 6) Infrastructure Development, 7) CO_2 Procurement, 8) Transportation and Injection Operations, 9) Operational Monitoring and Modeling, 10) Site Closure, 11) Postinjection Monitoring and Modeling, 12) Project Assessment,

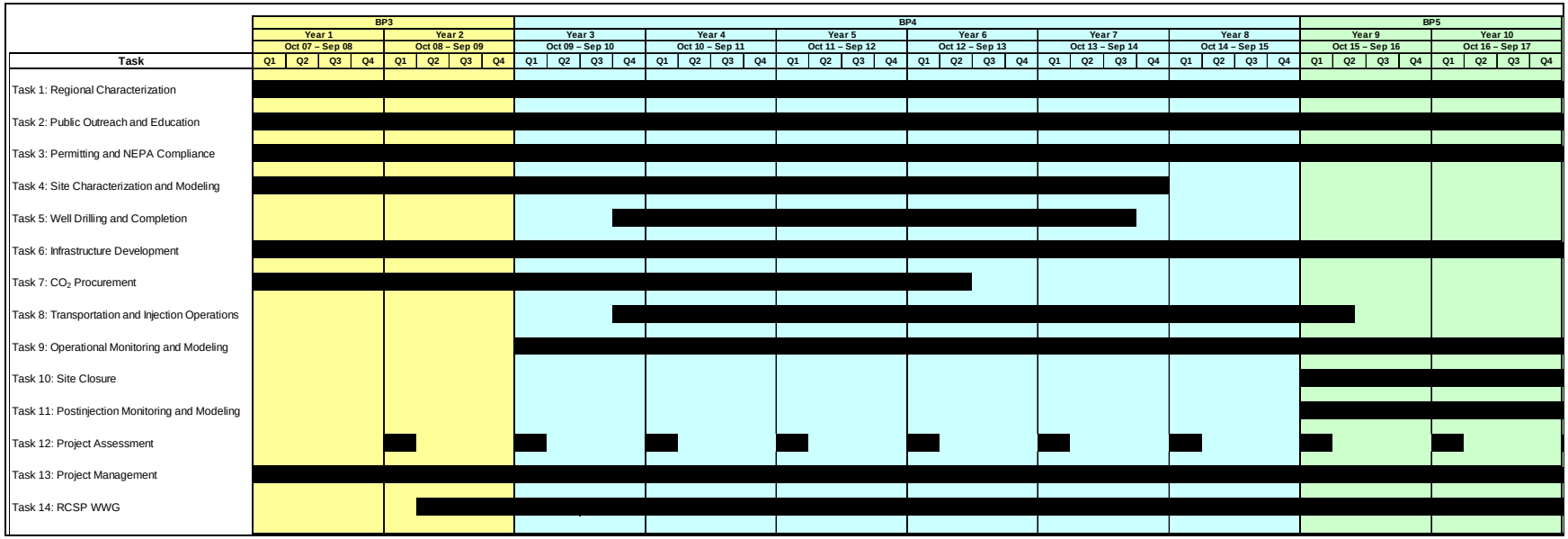


Figure 3. Phase III tasks.

13) Project Management, and 14) RCSP Water Working Group (WWG) Coordination. See Table 2 for the responsibility matrix of these fourteen tasks.

The EERC entered into a cooperative agreement with DOE NETL for Phase III activities in late September 2007. Phase III is a 10-year project, in three BPs, running from October 1, 2007, to September 30, 2017. This Annual Assessment Report summarizes the activities for PY3 (October 1, 2009 – September 30, 2010) for Phase III.

ASSESSMENT SUMMARY

In BP3, the focus of the program was to select two regionally significant, yet different, geologic formations for large-volume (approximately 1 million tons of CO_2 a year) commercial tests designed to demonstrate that CO_2 storage sites have the potential to store regional CO_2 emissions safely, permanently, and economically for hundreds of years. The Fort Nelson test site was selected in December 2007 and involves MVA support for the injection of up to 2 Mt/year CO_2 captured from one of the largest gas-processing plants in North America into a saline formation in British Columbia, Canada. The Bell Creek test site was selected in September 2009 and involves injection of CO_2 into formations in the PRB in southeastern Montana for the dual purpose of CO_2 storage and EOR.

Strong project management is crucial to the success of any project. The PCOR Partnership project management team focuses on providing timely completion of milestones, quality deliverables, accurate and timely project reports as directed in the Federal Assistance Reporting Checklist, and effective communication between the PCOR Partnership and DOE NETL management. All required deliverables, milestones, and project reports were completed on schedule during PY3. These included eight required reports, achievement of mandatory

Table 2. Phase III Responsibility Matrix

Phase III Task Title	Task Leader
Task 1 – Regional Characterization	Wesley D. Peck
Task 2 – Public Outreach and Education	Daniel J. Daly
Task 3 – Permitting and NEPA Compliance	Lisa S. Botnen
Task 4 – Site Characterization and Modeling	James A. Sorensen
Task 5 – Well Drilling and Completion	Steven A. Smith
Task 6 – Infrastructure Development	Melanie D. Jensen
Task 7 – CO_2 Procurement	John A. Harju
Task 8 – Transportation and Injection Operations	Steven A. Smith
Task 9 – Operational Monitoring and Modeling	Charles D. Gorecki
Task 10 – Site Closure	TBA
Task 11 – Postinjection Monitoring and Modeling	TBA
Task 12 – Project Assessment	Katherine K. Anagnost
Task 13 – Project Management	Edward N. Steadman
Task 14 – RCSP Water Working Group Coordination	Charles D. Gorecki

milestones, and four quarterly progress reports. Several value-added (noncontractual) reports were also prepared including a regional emissions and capture opportunities assessment, a sampling protocol for MVA of terrestrial carbon sequestration soils, an update to the public Web site, and a fact sheet for the RCSP WWG.

In November 2009, the PCOR Partnership participated in a RCSP annual project review meeting in Pittsburgh, Pennsylvania, and in December 2009 hosted a partners-only annual meeting in St. Louis, Missouri, to ensure that program goals are being met. EERC staff were also asked to present PCOR Partnership activities in March 2010 to then-Assistant Secretary of Fossil Energy, James Markowsky, in Washington, D.C. Throughout PY3, the PCOR Partnership was represented at over 55 conferences and meetings and submitted 45 abstracts, all but one of which were accepted with four currently remaining in review. The PCOR Partnership also submitted 20 technical papers and gave nearly 80 presentations (oral and poster combined).

The PCOR Partnership continued to post technical information about its program on its public Web site, reaching 3500 site visitors from over 50 countries in PY3. Over 800 copies of the PCOR Partnership Atlas, 3rd Edition, were distributed in PY3, and over 1100 DVD documentaries were given out free of charge. In addition, the Fort Nelson CCS Project received international recognition from the Carbon Sequestration Leadership Forum (CSLF) in October 2009 at its London ministerial meeting. Through these foregoing efforts, the CO_2 sequestration community is kept informed of the PCOR Partnership's accomplishments and activities.

Project management cannot be considered complete without identification of technical and nontechnical risks that may threaten successful project implementation. Accordingly, the PCOR Partnership prepared a risk management plan outline in September 2009 and has taken steps to assess programmatic as well as demonstration-project-level risks. During PY3, the EERC worked closely with the Fort Nelson demonstration site owners/operators to prepare a first-round risk assessment. Although this assessment includes business-sensitive information and is confidential, the PCOR Partnership has shared with the CCS community the methodologies used during the assessment.

In BP4, the focus of the program is to inject CO_2 at commercial scale at the two demonstration sites. For each site, the critical steps/decision points are 1) securing a CO_2 source, 2) permitting for pipelines and injection, 3) infrastructure development, 4) CO_2 injection, and 5) MVA implementation. Several years of injection and monitoring will be required in BP4 to move into the BP5 site closure and project wrap-up activities.

The CO_2 source has been secured for both the Fort Nelson and Bell Creek sites. In both cases, the CO_2 source is a natural gas-processing facility. Our commercial partner, Spectra Energy, owns the gas processing facility near the Fort Nelson site. The source of CO_2 for the Bell Creek site is the ConocoPhillips Lost Cabin Natural Gas Processing Facility, and our commercial partner (Denbury Resources Inc.) has secured the CO_2 from that facility for the next 15 years.

Permitting of the sites will require that the EERC complete the DOE Environmental Questionnaire and, possibly, provide assistance to our commercial partners with the completion

of the environmental assessment and/or environmental impact statement process where necessary. A permitting action plan is currently being prepared for the Bell Creek test site and will be fully developed in PY4.

The PCOR Partnership continues to establish and maintain excellent relationships with regional regulatory authorities. EERC staff participates fully in International Oil and Gas Compact Commission (IOGCC) efforts and serves on its Pipeline Transportation Task Force. In fact, John Harju, EERC Associate Director for Research, was appointed to the IOGCC executive committee in spring 2010. He was also appointed by the U.S. Secretary of Energy to serve as a member of the National Petroleum Council for the 2010–2011 membership term. In addition, the PCOR Partnership hosted its second annual regulatory workshop in July 2010, where oil and gas and pipeline regulators met informally to develop strategies to work past state/provincial boundaries and to establish rules and regulations outside of federal mandate. These relationships will prove invaluable as permitting activities progress.

For both demonstration sites, the pipeline routes are under development, and preliminary pipeline-permitting processes have begun. In January 2010, at the Fort Nelson site, a slant drill operation was conducted off the well that was drilled the previous year. This reentry of the borehole in the target reservoir allowed a variety of tests (well logging, leakoff tests, and water injection tests) to be conducted on the well to further understand the injection target. In addition, there were several updates to the petrophysical model, and simulations were rerun to determine the long-term fate of the sour CO_2 with the new well locations. It is expected that the Bell Creek MVA plan development will move forward briskly. Although the Bell Creek test site was selected in fall 2009, Denbury's merger acquisition of Encore postponed project negotiations for approximately a year. Now that its postacquisition integration activities have progressed and a meeting at Denbury's headquarters was scheduled for October 2010, it is anticipated that activity will be back on track in PY4.

Ultimately, the success of the PCOR Partnership Program will be evidenced by a region that has a supportive population, an accommodating regulatory environment, and a vibrant commercial CCS industry. Through its outreach and education activities, its rapport with regional regulators and federal decision-makers, and its ongoing collaborative MVA activities with supportive partners, the PCOR Partnership is well on its way to achieving its goals.

The Annual Assessment Report provides information about the foregoing activities in more detail and is organized as set forth below:

- Progress update and budget status of the 12 tasks (Tasks 1–9 and 12–14) that were active in BP4, PY3 (October 1, 2009 – September 30, 2010)
- Accomplishments achieved during BP4, PY3 (October 1, 2009 – September 30, 2010)
- Description of planned BP4, PY4 (October 1, 2010 – September 30, 2011) activities

It should be noted that Tasks 10 and 11 will not be initiated until BP5.

BUDGET PERIOD 4, PROGRAM YEAR 3 ACTIVITIES (2009–2010)

Progress Report

BP3 included the first 2 years of Phase III, with activities initiated October 1, 2007. Thirteen tasks were originally scheduled for Phase III. A new task, Task 14, was added during PY2 of BP3. Out of the 14 tasks, 12 tasks were active during BP4, PY3, as shown in Figure 3. The progress update for those tasks is presented within this section. This Assessment Annual Report (Deliverable [D] 57) details activities beginning October 1, 2009, through the end of BP4, PY3 or September 30, 2010. Edward N. Steadman is the overall program manager and principal investigator (PI) and provides leadership in fully coordinating and integrating the activities of the PCOR Partnership. To facilitate the management of this project, task leaders were designated as shown in Table 2.

Task 1 – Regional Characterization

The PCOR Partnership continues to refine the characterization of sources, geologic and terrestrial sinks, and infrastructure within its region. The goal is to further refine the assessment of the region's CO_2 production and storage potential in an effort to optimize source–sink opportunities within the region. This continued regional characterization will be used to refine capacity estimates for DOE NETL's national atlas and to provide context for extrapolating the results of the large-scale demonstrations.

Activities and Results

Phase III regional characterization efforts for BP4, PY3 (October 1, 2009 – September 30, 2010) are addressed below.

Review and Update Attribute Data for CO_2 Source Locations Within the Region

The PCOR Partnership maintains a database of significant regional point sources of CO_2. The database is key in the development of CO_2 capture–transportation–sequestration scenarios that have the potential to reduce greenhouse gas (GHG) emissions in the PCOR Partnership region. To maintain a reasonably current status, the data set undergoes an annual review during which new or missing sources are identified and added, CO_2 emission rates are updated, and facility locations are verified. The review that took place in PY3 addressed all of these areas. As of September 15, 2010, the updated PCOR Partnership database contains 966 sources that produce an estimated 594.37 million short tons of CO_2 annually. This compares to the September 2009 values of 927 sources producing an estimated 561.89 million short tons of CO_2 annually.

Second Target Area Initiated

In PY2, the PCOR Partnership completed a detailed site characterization for its first target area, the Dickinson Lodgepole Mounds (including the Eland oil field) near Dickinson, North Dakota.

Work has since begun in the Rival oil field located in northwestern North Dakota (Figure 4). This field has been identified as a potential target area for CO_2 storage and CO_2 EOR activities and is currently home to an acid-gas injection disposal unit in Burke County, North Dakota.

The Bear Paw Energy Lignite Gas Plant has been disposing of approximately 0.5 Mcf/day (85 bbl/day) of acid gas (50% H_2S, 42% CO_2) into the Mission Canyon Formation, Mohall through Glenburn subintervals since September 4, 2002. The Rival oil field is just over 20 mi^2, and the entire study area is just over 100 mi^2. Over 16 MMbbl of oil have been produced since the late 1950s, and most recovery is now secondary production from water flooding. The productive interval is at a depth from 5900 and 6200 feet. History matching is under way, and prediction runs will be made to determine incremental oil recovery potential, along with the amount of CO_2 subsequently stored.

An abstract on characterization and modeling of the Rival oil field for potential CO_2 EOR was submitted in September 2010 for the American Association of Petroleum Geologist's (AAPG's) 2011 Annual Conference & Exhibition (www.aapg.org/houston2011). Authors will be notified of acceptance or rejection in November 2010.

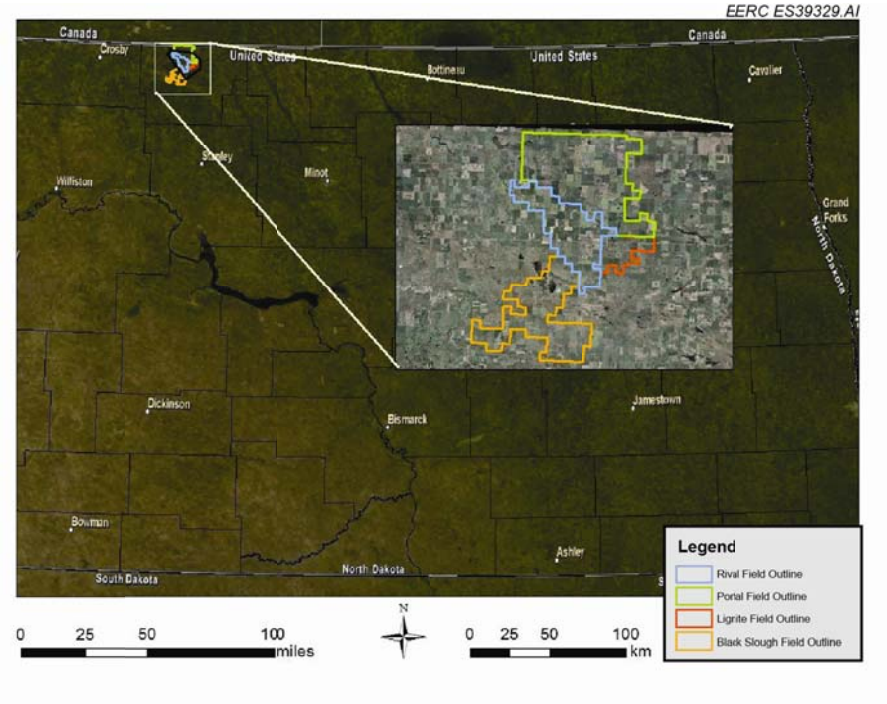


Figure 4. Location of the Rival oil field in northwestern North Dakota.

Refine Storage Analogs for Specific Geologic Horizons Within the Regional Basins

There are eight depositional basins lying fully or partially within the PCOR Partnership region (see Figure 5). To date, PCOR Partnership staff has assessed a portion of all of the oil-bearing basins in its region, namely, the Alberta, Williston, Powder River, and Denver–Julesberg Basins. Efforts are under way to expand the number of assessed target formations in these basins. The largest of these efforts is aimed at characterizing the Basal Cambrian saline formation system lying across the Alberta and Williston Basins. Other planned activities include participation in an effort to evaluate the relatively underexplored Forest City Basin. It has been determined that minimal benefit to the program would be derived from exploration of the Midcontinental Rift System in Minnesota and Iowa.

Preparation of a preliminary report was continued on the Cedar Hills Formation in western Nebraska—the geologic horizon is a promising saline formation target for CO_2 storage. Efforts in this program year include the collection of well data, a literature review of earthquakes and active faults in western Nebraska geology that may affect storage and security volume, and collection of preliminary oil field data from the portions of Colorado and Kansas that border the oil field region of western Nebraska.

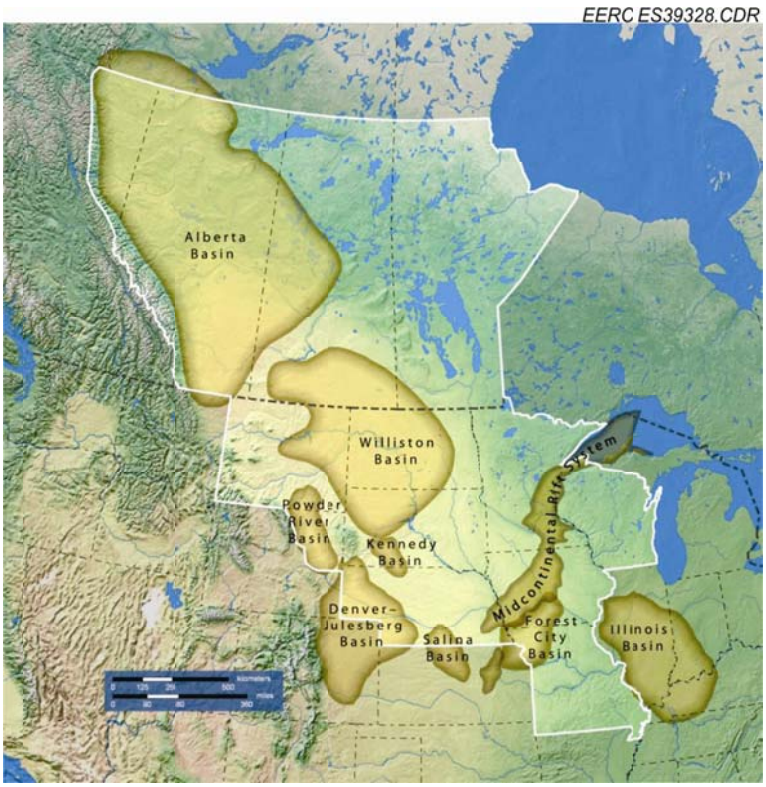


Figure 5. Regional basins located throughout the PCOR Partnership region.

Work with Geological Surveys/Oil and Gas Divisions

Missouri Division of Geology and Land Survey

The Missouri Department of Natural Resources, Division of Geology and Land Survey (MO DGLS), was added as a PCOR Partnership member and subcontractor on March 13, 2008, to provide baseline data and characterization regarding the potential geologic sequestration of CO_2 in Missouri. Information about Missouri-specific data was gathered from October 1, 2008, through March 31, 2010. Currently, the information provided is under review, and a value-added report will be prepared.

MO DGLS is currently exploring opportunities and potential regional interest in the characterization of the Forest City Basin located in the four corners of Nebraska, Iowa, Missouri, and Kansas (Figure 5). PCOR Partnership staff participated in several conference calls, as well as attended a meeting held in May 2010 in Rolla, Missouri.

Nebraska Geological Survey

Efforts continued in PY3 to enter into a subcontract with the Nebraska Geological Survey and/or the Nebraska Oil and Gas Commission to aid in the assessment of carbon storage opportunities in that state. In the meantime, several meetings were held with commercial partner(s) in Nebraska that may be interested in funding a carbon management plan, including characterization and assessment of potential CO_2 needs for EOR opportunities in western Nebraska. Discussions are ongoing at this time.

PCOR Partnership Atlas

The PCOR Partnership Atlas provides an introduction into the concept of global climate change and a regional profile of CO_2 sources and potential sinks across the nearly 1.4 million square miles of the PCOR Partnership region of central North America. This atlas is slated for revision on a biennial basis, i.e., 2009, 2011, etc., or the alternate years for DOE NETL's update of the carbon sequestration atlas of the United States and Canada.

The PCOR Partnership Atlas, 3rd edition (Figure 6), included over ten new pages of information, including individual page spreads on the Phase II field validation test sites and an introduction to the Phase III commercial-scale demonstration projects. This atlas continues to serve as an excellent resource as well as a valuable outreach tool. A copy has been provided to each partner contact either in person at the annual meeting held in December 2009 or via delivery in January 2010. In addition, the atlas is distributed to visitors, educators, libraries, and conference attendees and upon request. All 800 copies of the 3rd edition were distributed during PY3. Plans are currently under way to order a second printing.

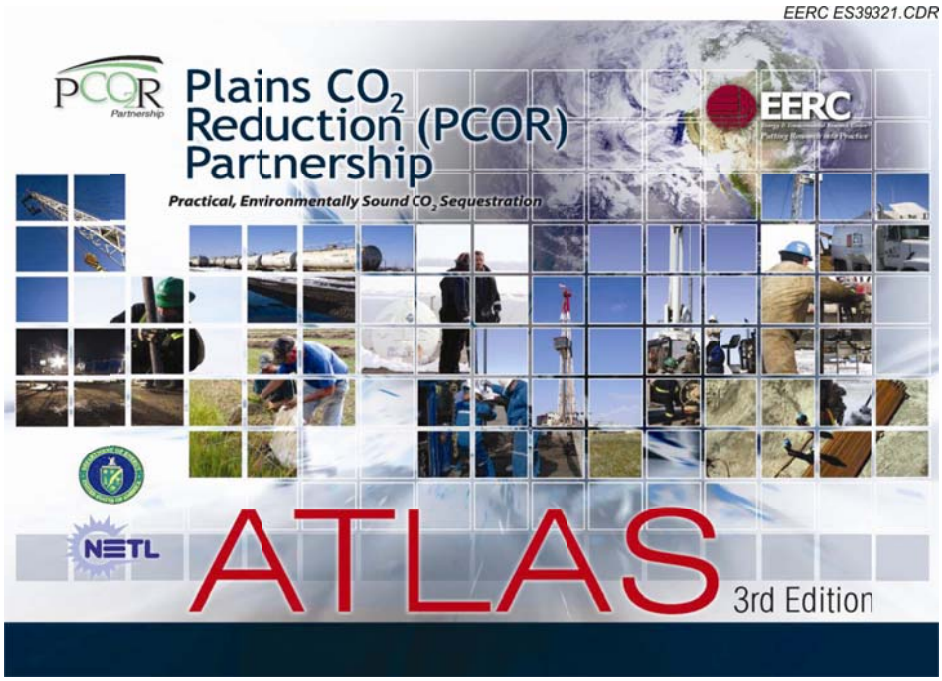


Figure 6. PCOR Partnership Atlas, 3rd Edition, released December 2009.

Updating the DSS

Since the site redesign was reported to DOE NETL in September 2009, modifications and refinement to the partners-only Decision Support System (DSS, © 2007–2010 EERC Foundation) are continually undertaken to ensure the timely dissemination of data and information as well as to help improve the quality and efficacy to our partners for their carbon management decisions. Efforts undertaken in PY3 include the following:

- Completed new risk management, carbon markets, and regulatory sections.
- Performed a data review and cleanup to make management of the system easier and more intuitive.
- Developed a media gallery utilizing a Flash-based navigation interface for browsing for over 200+ photos, maps, and illustrations. Detailed information for each image was added, including a title, description, and category. This allows for a search function to be used (Figure 7).
- Updated the general "CO_2 in the Region" and "Geologic Sinks" information.
- Continued populating the products database with presentations, reports, posters, and products.

Figure 7. Screen capture of the DSS image gallery showing the browse and search function, description, and choice of resolution available.

- Initiated redesign of a new geographic information system (GIS) interface to deliver a more productive user experience. Toward this end, GIS metadata have been compiled for sources, saline formations (Madison, Maha, and Viking), sedimentary basins, Prairie Pothole Region, coal basins, and coal basin assessment areas (Ardley, Hanson–Hanson, and Wyodak–Anderson). GIS layers are also under creation for a map/poster portrayal of the PCOR Partnership region focusing on the relationship between Native American lands, CO_2 sources, and sink opportunities.

Development of a Demonstration Project Reporting System (DPRS)

Collection of information specific to the demonstration sites is ongoing in an effort to populate a Web-based interface to house the data and facilitate communication and interpretation of the data. Plans for the DPRS include structured access to data by all demonstration participants and other partners and to allow for the efficient replication of additional or related demonstration projects. On September 14, approval was received from DOE NETL to extend D10 entitled "Demonstration Project Reporting System Update" from its due date on September 30, 2010, to March 31, 2011. This additional 6 months will provide the time necessary to acquire and interpret information regarding the Phase III demonstration sites prior to upload.

Further Characterization of the Zama Acid Gas EOR, CO_2 Storage, and Monitoring Project

The Zama oil field in Alberta, Canada, was one of the geologic storage validation test sites during Phase II of the program. This project focused on the injection of acid gas into a partially depleted oil field for the simultaneous purpose of acid gas disposal, CO_2 storage, and EOR. Because of the useful results and positive outcomes developed throughout the Phase II project, the site owner, Apache Canada Ltd. (Apache), was amenable to participation in follow-on characterization efforts at the Zama site. Accordingly, in June 2010, DOE NETL approved the furtherance of the work that was performed in the Zama oil field during Phase II. A new deliverable was added for this new work, i.e., D86, which will provide an updated regional technology implementation plan for the Zama project. The expected period of performance for this add-on work is 2 years with an anticipated start date of July 2010. Because of a change in the site operator's project lead, work was delayed until August 2010, but has since been ongoing.

Efforts conducted during BP4, PY3 (October 1, 2009 – September 30, 2010) as part of the continuing work at the Zama site included the following:

- Planning activities with specific focus on feasibility analysis of the deployment of vertical seismic profiling (VSP) field work and wellbore integrity laboratory experimental design setup.

- Discussions with site host, Apache, to determine the best VSP design conditions that optimize data sets for input into a new geological model of the pinnacle, long-term verification, and improved understanding of reservoir performance.

- Experimental design of wellbore integrity laboratory-based studies. It is anticipated that implementation of these tests will begin in early November 2010.

- Participated in a project meeting with Apache on August 30, 2010. The following action items were determined:

  – The EERC will acquire new seismic data over the "F Pool," tracer injection, and fluid sampling.

  – Apache will conduct a brief evaluation of seismic techniques.

  – The EERC will generate a list of data needs for the creation of a static geological model of the pinnacle.

- Continued efforts to perform laboratory studies on the cement types utilized in the Zama wells to determine the likelihood of potential reactions and the implications to the integrity of the system.

- Developed a preliminary static model of the Zama "F Pool" based on data sets collected over the past four program years. Continued planning efforts to improve the model, including collection of the following data:

  – Geologic framework, degrees of heterogeneity, and reservoir properties
  – Injection target and sealing formation data from Apache
  – Seismic information acquired after the winter drilling season

- Participated in the 10th International Conference on Greenhouse Gas Control Technologies (GHGT-10) in Amsterdam, the Netherlands, and gave an oral presentation on September 22, 2010 entitled "Zama Acid Gas Enhanced Oil Recovery, CO_2 Sequestration, and Monitoring Project."

DOE NETL Carbon Sequestration Atlas of the United States and Canada (Atlas III)

The primary purpose of *Atlas III* is to update U.S./Canadian CO_2 storage potential and provide updated information on the activities of DOE's seven RCSPs, as well as DOE's Carbon Sequestration Program and international CCS collaborations. It also presents updated information on the location of CO_2 stationary source emissions, as well as the locations and geologic storage potential of various formations, and it provides details about the commercialization opportunities for CCS technologies from each RCSP, including the PCOR Partnership. The CO_2 geologic storage resource calculation methodology of *Atlas III* will also be updated to better reflect uncertainties in geologic formation properties.

In order to support *Atlas III* efforts, the PCOR Partnership participated in multiple conference calls to discuss progress of the data compilation and provided data via NATCARB (DOE NETL's distributed NATional CARBon Sequestration Database and Geographic Information System), including aggregated characterized saline aquifer data, recalculated regional coal capacity information, and new GIS layers. In addition, new text and images were prepared on the background of the PCOR Partnership, as well as for each of its Phase II field validation tests and its planned Phase III demonstration projects and outreach activities. The new information was provided in July 2010. Release of Atlas III is expected in November or December 2010.

RCSP GIS Working Group

The task lead attended and participated in the RCSP GIS Working Group meetings in November 2009 and May 2010, both in Pittsburgh, Pennsylvania. He also participated in the monthly conference calls with representatives from the other regional partnerships.

Training and Presentations

- The task lead attended the North Dakota GIS Conference in November 2009, in Grand Forks, North Dakota. The conference was attended by nearly 200 people from around the region and consisted of presentations and workshops. The conference also provided an opportunity to meet with several industry representatives. These meetings proved to

be very helpful and contributed greatly to addressing some current challenges with regard to the PCOR Partnership DSS and with issues under discussion with the RCSP GIS working group.

- The task's research specialist attended the Environmental Systems Research Institute, Inc., International User Conference for GIS technology in July 2010 in San Diego, California.

- In June 2010, the task lead presented an overview of PCOR Partnership activities at the Rocky Mountain Section of the AAPG in Durango, Colorado.

Task 2 – Public Outreach and Education

This task provides outreach and education mechanisms to raise awareness regarding CO_2 storage opportunities in the region as well as outreach to select target audiences concerned with the demonstration activities.

Activities and Results

Accomplishments during BP4, PY3 (October 1, 2009 – September 30, 2010) are described below.

Outreach Planning

An update to the PCOR Partnership outreach action plan (D11) was prepared in March 2010. This plan describes the activities undertaken and products developed to help raise awareness of both the practice of sequestration, in general, as well as the PCOR Partnership, in specific. The plan is developed to reach three types of audiences: the general public across the region, key audiences at the regional level and, in collaboration with project partners, audiences in the vicinity of the planned Phase III demonstrations. Outreach activities will be facilitated by the outreach materials developed during Phase I and II efforts, as well as additional materials to be developed under Phase III.

Data Acquisition and Management

The outreach data management system, an addition to the DSS, will consist of GIS-compatible databases. These databases will contain information needed to plan, track, and assess outreach actions as well as to produce thematic maps and other products to aid in outreach activities. In PY3, collection of information to populate the databases with demographics, sequestration activities, and outreach activities continued. The demographic information included population distribution. Information collected on outreach networks included source and coverage areas for print media (magazines and newspapers), school districts, public television source and coverage, science educators, government groups, community organizations, and select service clubs. Work is ongoing toward the development of meeting lists for key organizations.

Public Web Site (www.undeerc.org/pcor)

The public PCOR Partnership Web site will be updated and expanded as appropriate, with major updates on a biennial basis, i.e., 2010, 2012, 2014, and 2016.

In January 2010, the Web site update (D13) included the following: a revised home page; new pages, e.g., a request information link, information on CCS, information on the *Global Energy and Carbon: Tracking Our Footprint* documentary; a video clip library; and updated pages, e.g., regarding educators, the PCOR Partnership team, the site map, etc.

In June 2010, additional (nonrequired) updates to the Web site were completed, including the following: a revised video clip gallery format (Figure 8), 29 additional video clips, and three updated Web pages.

Public Web Site Traffic

There were 1895 visits (not to be confused with "hits") to the PCOR Partnership public Web site from late February when tracking began to the end of September 2010. Google Analytics is utilized to track the data. Of the 1895 visits, 1077 were unique visitors to the web site. Visitors from 51 countries spent time on the public Web Site.

On average, three pages were viewed a visit. A breakdown of how visitors arrived at the Web site is found in Figure 9, including direct traffic (57.20%), search engines (24.96%), referring sites (17.78%), and other (0.05%).

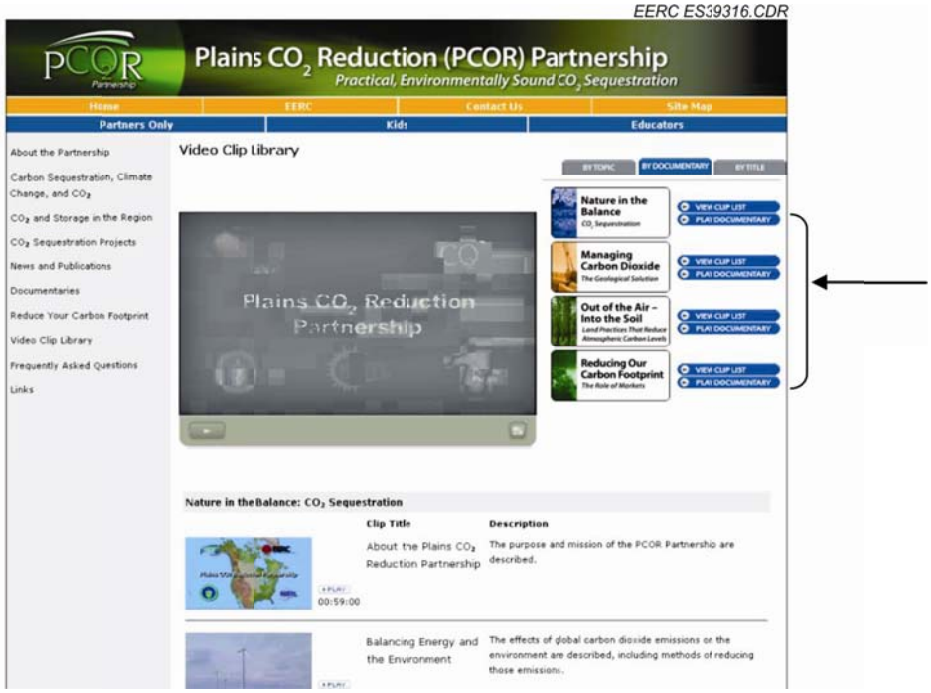


Figure 8. Public Web site video clip library "By Documentary" page.

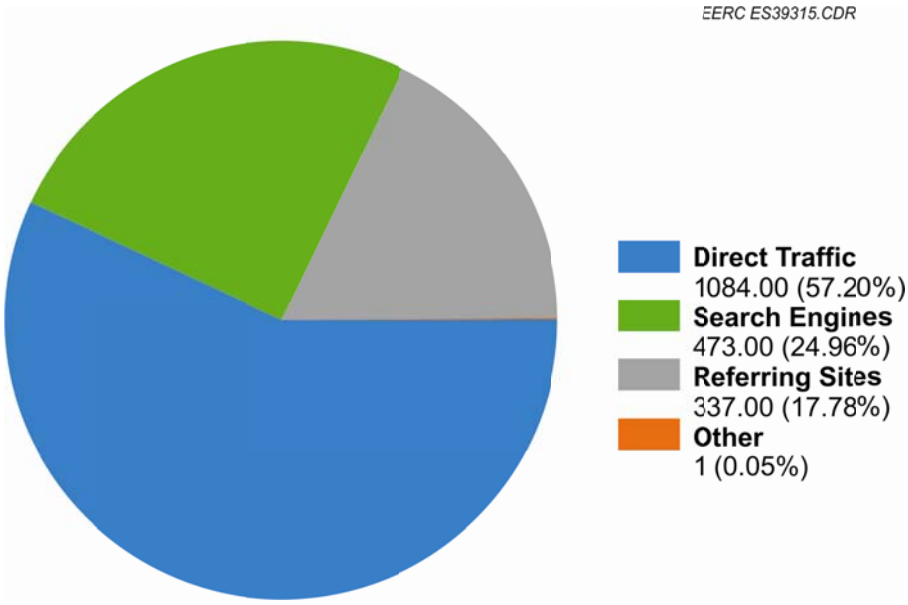


Figure 9. Web site traffic sources.

The top three pages viewed were the following: 1) the "CO_2 Projects" page was the most visited Web page (www.undeerc.org/PCOR/co2seqprojects/default.aspx), followed by 2) "About the PCOR Partnership" (www.undeerc.org /PCOR/about/default.asp), and 3) "News and Publications" (www.undeerc.org /PCOR/newsandpubs/default.aspx).

Fact Sheets

New fact sheets will be created with general background information on the PCOR Partnership Phase III program and a profile on each of the demonstration projects. These fact sheets, along with the ones developed in previous phases, will be updated as needed. Other fact sheets may be developed as needed.

In response to a request by the site owner, an update was undertaken in collaboration with Spectra Energy for Fact Sheet No. 16, regarding the Fort Nelson site (D16), entitled "Geologic Storage of Sour CO_2 from a Natural Gas-Processing Plant – A Commercial Demonstration."

In addition, a review of the current fact sheets was conducted, and it was determined that a new format along with updated information was necessary. Plans were initiated to update existing fact sheets and develop new ones to be used within the overall context of PCOR Partnership outreach activities. In PY3, several in-house planning meetings were held, and ideas for a new design and layout were explored.

PowerPoint Presentations

PowerPoint presentations will be developed for Phase III general activities as well as for each of the demonstration projects. Other PowerPoint presentations may be developed, and PowerPoint presentations will be updated as needed.

A PowerPoint presentation (D19) focused on the Fort Nelson demonstration was prepared and completed in July 2009. An update to this presentation was submitted and approved in June 2010.

In May 2008, a general Phase III information PowerPoint presentation (D17) was prepared. This presentation entitled "General Audience CO_2 Sequestration Outreach PowerPoint Presentation" was also updated in June 2010.

Outreach Working Group

The RCSP Outreach Working Group (OWG), comprising representatives from each of the seven regional partnerships, recognizes the importance of conducting public outreach in tandem with successful field tests. Its members pool their experiences and resources in an effort to provide a foundation for future commercialization efforts and even more extensive outreach efforts. Based on contributions by the outreach leads of the seven regional partnerships, DOE NETL's outreach best practices manual entitled "Public Outreach and Education for Carbon Storage Projects" was released in December 2009.

Other examples of the PCOR Partnership's participation in the OWG during PY3 included the following:

- Created the OWG logo banner in November 2009 (Figure 10).
- Participation in the monthly OWG conference calls.
- In collaboration with the OWG and the Petroleum Technology Research Centre (PTRC) in Regina, Saskatchewan, attended the 9th Annual Conference on Carbon Capture and Sequestration in Pittsburgh, Pennsylvania, and presented the following:
  - "Covering the Bases – Regional and Project Level Outreach for Sequestration," presented on May 12, 2010, in the Outreach and Education technical concurrent session.
  - "Development of a Manual for Public Outreach Best Practices," presented on May 12, 2010 in the Initiatives under the U.S.–Canada Clean Energy Dialogue technical concurrent session.

Figure 10. Example of the RCSP Outreach Working Group banner bearing the logos of all seven regional partnerships and DOE NETL.

- Assumed a lead role in the OWG to submit an abstract and paper for, and present at, GHGT-10 in Amsterdam in September 2010. In addition to the poster presentation, the task lead participated on a panel in a side meeting held by the Bellona Foundation, an international environmental nongovernmental organization based in Norway, and participated in a meeting of the International Energy Association's (IEA's) Social Science Network.

- In June 2010, participated in the OWG's workshop in Washington, D.C., exploring implications of increased outreach activity at the DOE headquarters level.

- Prepared a poster on behalf of the OWG highlighting the Aquistore (Canada) project's and RCSPs' use of outreach best practices for presentation at the RCSP Annual Review Meeting scheduled for October 2010 in Pittsburgh, Pennsylvania.

Posters

Posters intended for a general audience will be developed. In March 2009, a general outreach poster (D24) was completed. Efforts were undertaken for individual posters profiling the demonstration projects. The Fort Nelson test site poster (D26) was scheduled for September 2010, and the Bell Creek test site poster (D27) was scheduled for July 2010. Because of reorganizational (postacquisition transition) delays for the site owner, an extension to September 2011 for the Bell Creek test site poster was granted in June 2010. In August 2010, a change was requested and approval received for the due date of the Fort Nelson test site poster. The poster is now due in March 2011, to allow the incorporation of images that will be obtained on a site visit tentatively scheduled for February 2011 and to allow the inclusion of information from core analyses.

Documentaries and Video Products

A spectrum of video products will be developed to meet the need of general and site-level outreach. Thirty-minute broadcast-quality documentaries will be produced in partnership with Prairie Public Broadcasting (PPB), be broadcast in the PPB market area, be made available to other public broadcasting markets for possible broadcast, be placed on the public Web site, and

be available as DVDs. Video segments and products intended for use in PowerPoint presentations and public Web pages will also be developed.

Managing Carbon Dioxide: The Geologic Solution (Figure 11) was produced by PPB in collaboration with the PCOR Partnership. The 30-minute documentary explores the story of geologic CO_2, enhanced oil recovery, and geologic CO_2 sequestration – a 100-year journey from a borehole venting CO_2 in the desert of northern New Mexico to a technology for managing carbon dioxide emissions from large industrial sources like power plants. The documentary premiered on November 10, 2009, on Prairie Public television. A copy of the DVD was provided to each partner contact either in person at the annual meeting held in December 2009 or via delivery sent January 2010. In addition, the DVD is distributed to visitors, educators, libraries, and conference attendees and upon request. Over 450 copies of the DVD were distributed during PY3. The documentary is also available in streaming version on the public Web site, along with various excerpted video clips.

Efforts continued throughout PY3 on finalizing the fifth documentary entitled *Global Energy and Carbon: Tracking Our Footprint* (Figure 11). This documentary will follow families in the United States, India, and Cameroon to examine how energy is used in three economies: industrialized, emerging, and developing. A revised draft version was provided to DOE NETL for review in March 2010. Comments from DOE NETL, in-house focus groups, and EERC management were incorporated into the documentary, along with original graphics, new narration, and editing. The documentary premiered on October 18, 2010, on Prairie Public television.

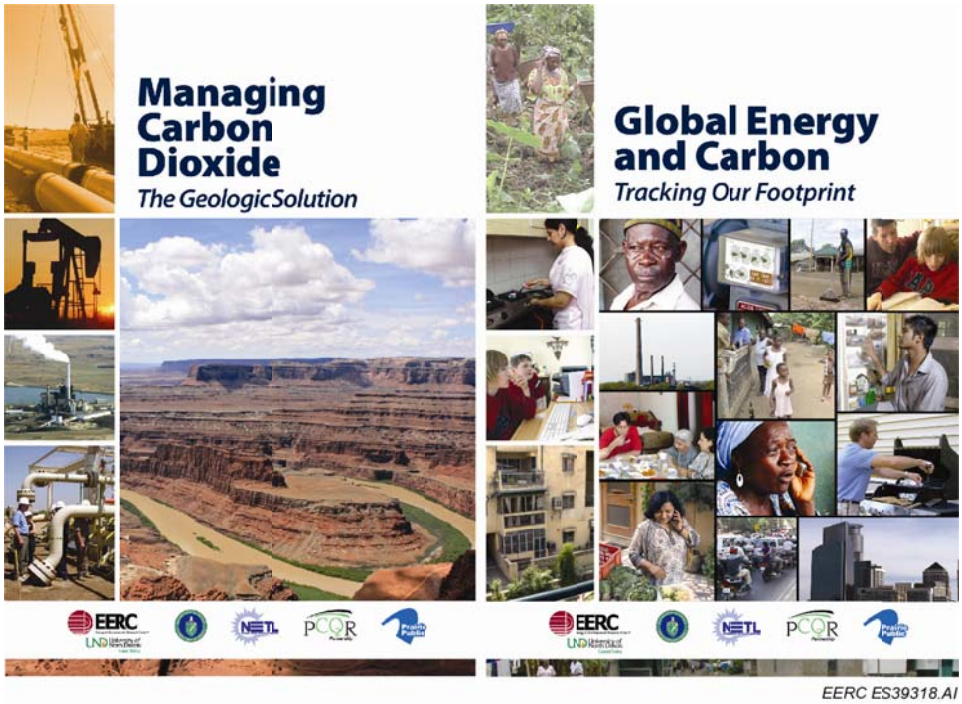


Figure 11. Cover art for the fourth and fifth documentaries produced by PPB and the PCOR Partnership.

In PY3, additional video segments were created from the documentary products and other materials held by PPB. The clips are under 5 minutes in length and are intended to supplement the PowerPoint presentations and the publicly accessible Web site. Twenty-nine video clips from the first four documentaries have now been uploaded to the public Web site. Efforts to develop the protocol, format, and capability to upload the video clips to a video-sharing Web site, e.g., YouTube, are continuing.

Additional Outreach Activities

The outreach team will identify and act on opportunities to provide outreach both at the regional level and in the vicinity of the demonstration projects. Activities undertaken in PY3 include the following:

- Initiated a system for more formal outreach tracking efforts, e.g., tracking the distribution of outreach materials, media coverage, presentations, conference attendance and exhibit booth displays.

- Discussed plans for an improved method for archiving and managing video images in collaboration with PPB.

- Discussed plans with EERC library staff to develop outreach strategies involving regional libraries. This included development of an exhibit booth for the North Dakota Library Association (NDLA) 2010 Annual Conference held September 29 – October 2, 2010, in Grand Forks as the next step in the efforts to encourage area libraries to stock the PCOR Partnership atlas and documentaries to help reach the general public and school-aged children.

- Received notification on September 22, 2010, that the Government Documents Roundtable of NDLA had nominated "Managing Carbon Dioxide: The Geologic Solution" (DVD) for its 2010 Notable Document Award; the Roundtable then distributed the PCOR Partnership link for the online streaming version of the documentary to all 350 NDLA members.

- Participated in regional teacher education seminars including:

  – In June 2010, gave presentations and distributed outreach materials to a group of approximately 40 teachers at the North Dakota Petroleum Council's (NDPC's) 2010 Teacher Education Seminar held in Bismarck, North Dakota.

  – Also in June 2010, gave a presentation and distributed outreach materials to a group of approximately 125 teachers at the Lignite Energy Council's (LEC's) 2010 Lignite Education Seminar: Energy, Economics, and Environment held in Bismarck, North Dakota.

- Participated in the Weyburn–Midale Outreach Advisory Panel including:

  – Participation in advisory teleconferences.
  – Review of the CCS 101 Web site and other outreach materials.

- Participated in the Aquistore Project Communications Advisory Group including:

  – Accepted an advisory role for outreach for sequestration projects to be developed through PTRC in Regina, Saskatchewan, Canada; attended a meeting with the PTRC in October 2009, in Regina to help lay the groundwork for select Saskatchewan sequestration projects (representatives of the Midwest Geological Carbon Sequestration Consortium and Schlumberger also attended); and continued to review materials and participate in conference calls.

Task 3 – Permitting and NEPA Compliance

The overall goal of Task 3 is to advance the regulatory and permitting framework for CO_2 storage projects in North America as well as to assist the demonstration site owners as necessary in obtaining the permits and approvals needed for the projects to comply with state, provincial, and federal requirements.

Activities and Results

The PCOR Partnership continues to stay abreast of federal legislative actions occurring in the United States and Canada and follows the developments of various state, provincial, and regional initiatives. Internal documents that outline the activities of these groups are updated on a regular basis. Reviews continue of publications relating to the regulation of CO_2 sequestration, MVA issues, and carbon market developments. Updates are provided to task leaders with regard to federal, state, and provincial actions. In addition, the regulatory section on the DSS is updated regularly.

Accomplishments during BP4, PY3 (October 1, 2009 – September 30, 2010) also included the following.

- Continued to follow committee hearings and actions on the Boxer–Kerry Climate Change bill.

- Followed the activities of the climate talks in Copenhagen (COP 15).

- Reviewed U.S. Senate Bill 2889 named the "Surface Transportation Board Reauthorization Act of 2009" to identify potential implications for CO_2 pipelines.

- In February 2010, the PCOR Partnership presented at the Texas Carbon Capture and Storage Association CO_2 Storage Policy seminar and attended the 2010 Carbon and Climate Change Conference in Austin, Texas.

- In July 2010, the PCOR Partnership attended the 4th Annual Carbon Capture & Sequestration: The Business Summit in Washington, D.C. In addition to relevant topics

discussed, this conference provided an opportunity to meet and interact with partners and RCSP participants.

- Prepared a summary of the August 12, 2010, report of the President's Interagency Task Force on Carbon Capture and Storage and reviewed the 233-page document (www.epa.gov/climatechange/downloads/CCS-Task-Force-Report-2010.pdf).

- Reviewed a 96-page report entitled "The Legal and Regulatory Treatment of Carbon Capture and Storage (CCS) in Canada and the United States" prepared by Nigel Bankes for Natural Resources Canada.

- In September 2010, attended the NDPC annual meeting in Minot, North Dakota.

- Initiated development of a "regulatory roundup" report to be distributed at the annual meeting scheduled for October 2010.

NEPA Environmental Questionnaires

The environmental questionnaire for "Further Characterization of the Zama Acid Gas EOR, CO_2 Storage, and Monitoring Project" (Subtask 1.4) was submitted in May 2010, and in June 2010, the project received a categorical exclusion for the period of time June 1, 2010 – May 31, 2012.

Interstate Oil and Gas Compact Commission

The IOGCC is a multistate government agency that promotes the conservation and efficient recovery of domestic oil and natural gas resources while protecting health, safety, and the environment. The IOGCC's Pipeline Transportation Task Force (PTTF) was formed in April 2009 to undertake a scoping on behalf of states on the issue of CO_2 pipeline transportation. The main outcome of the task force will be to produce a report to help states and other stakeholders begin to understand the issues that will need to be addressed in citing and regulating new CO_2 pipelines.

EERC staff participated in numerous conference calls of the IOGCC PTTF and provided review and comment on multiple iterations of the regulatory framework report on CO_2 pipeline infrastructure issues. An IOGCC survey on PCOR Partnership Phase II field validation site permitting issues was completed for use at the IOGCC RCSP "Lessons Learned" exercise, and EERC staff participated in that meeting in Santa Fe, New Mexico, in January 2010.

EERC staff attended the IOGCC Midyear Issues Summit in May 2010 in Lexington, Kentucky, and the IOGCC was represented at the PCOR Partnership's annual meeting in St. Louis, Missouri, in December 2009, and at its second annual regulatory meeting held in Deadwood, South Dakota, in July 2010. Several conference calls were held with IOGCC personnel after the Deadwood meeting about expanded collaborative efforts regarding the timely communication of regulatory issues.

U.S. Environmental Protection Agency's (EPA's) Proposed Rules

Proposed Rules for CO_2 Geologic Sequestration Wells

After an assessment on the impact to the PCOR Partnership members and region, comments were submitted in October 2009 to the EPA's recent release of additional data relating to the geologic sequestration of carbon dioxide under the "Federal Requirements under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO_2) Geologic Sequestration Wells; Notice of Data Availability (NODA) and Request for Comment" announced August 24, 2009. The NODA contained supplemental information previously not available during the initial publishing of the proposed regulations on geologic sequestration. The NODA expanded upon information described in the July 2008 proposed rule related to new data and research concerning both GS projects and modeling.

Endangerment Finding and Proposed Tailoring Rule

In early December 2009, EPA issued an endangerment finding for emissions of GHGs. The finding lays the groundwork for EPA to promulgate rules under the Clean Air Act (CAA) limiting GHG emissions from various sources. The action allows EPA to finalize the GHG emission standards for light-duty vehicles, which then triggers stationary source permits under the Prevention of Significant Deterioration (PSD) and Title V operating permit programs. EPA proposed a PSD and Title V GHG tailoring rule in September 2009 to address this issue.

On May 13, 2010, EPA issued its final tailoring rule that would phase in stationary source permitting requirements. The Final Rule substantially increases the GHG permitting threshold requirements from those set forth in the September 2009 proposed rule. The first step begins on January 2, 2011, and runs through June 30, 2011. During the first phase, a facility's GHG emissions will not be subject to reduction under PSD unless the facility's non-GHG emissions independently trigger PSD and the facility's PSD-triggering event results in a GHG emission increase of 75,000 tons a year or more. Similarly, a facility will be subject to Title V permitting during the first phase only if the facility's non-GHG emissions trigger Title V. Therefore, during this first phase, no stationary sources will be subject to CAA permitting requirements because of GHG emissions alone.

The second step begins on July 1, 2011, and continues through June 30, 2013. This phase extends the applicability of GHG permitting to new sources and existing sources not already subject to Title V that emit at least 100,000 tons a year. In addition, PSD will be triggered by new facilities with the potential to emit 100,000 tons of GHGs a year or more, as well as modifications to existing facilities that will increase the potential to emit by 75,000 tons of GHGs a year.

In the Final Rule, EPA states that Step 3 will be subject to additional rulemaking to be complete by July 1, 2012. At this point, it is uncertain what this rulemaking will entail; however, EPA has committed that it will not require permitting for sources with GHG emissions below 50,000 tons a year under Step 3.

Mandatory GHG Reporting

An evaluation of the "Proposed Mandatory Reporting Rule" was conducted. Beginning January 1, 2010, fossil fuel and industrial gas suppliers, manufacturers of vehicles and engines outside of the light-duty sector, and certain downstream facilities that emit GHGs (primarily large facilities emitting 25,000 metric tons of carbon dioxide equivalent [$mtCO_2e$] or more of GHG emissions a year) are required to submit annual GHG emission reports to EPA. The first reports will be due on March 31, 2011.

Additionally, on March 22, 2010, EPA proposed amending the Mandatory Greenhouse Gas Reporting Rule to require reporting of emissions data from the oil and natural gas industries, industries that emit fluorinated GHGs, and facilities that inject and store CO_2 underground for the purposes of GS or enhanced oil and gas recovery. This proposal also requires GS facilities to develop and implement an EPA-approved monitoring, reporting, and verification (MRV) plan and report the amount of CO2 geologically sequestered using a mass balance approach. GS research and development (R&D) projects would not be required to develop MRV plans, but they would be required to report basic injection data. The first annual reports of CO2 injection amounts would be due to EPA by March 31, 2012, for injection that occurs in 2011. EPA plans to finalize these proposals this year.

North Dakota CCS Task Force

The PCOR Partnership participates on a task force that is working on GS issues for the state of North Dakota. The task force assisted in the development of GS legislation and rules for the state. The legislation was passed and signed into law by the governor in 2009, and the GS administrative rules were subsequently finalized in April 2010.

Fort Nelson Test Site

The PCOR Partnership has been supporting Spectra Energy's permitting efforts for the Fort Nelson demonstration. Legislative and regulatory actions by the province of British Columbia are continually followed for the effect they may have on the Fort Nelson demonstration project. During PY3, staff worked with British Columbia regulators on the development of a comprehensive review of acid gas and potential CCS regulations. This review included research of the British Columbia Oil and Gas Commission's permitting and reporting requirements, including the following:

- Acid gas permitting requirements
- Nonspecial waste permitting requirements
- Hydrocarbon storage permitting requirements
- Storage well monthly reporting requirements

Bell Creek Test Site

Because of reorganizational (postacquisition integration) delays experienced by the Bell Creek site owner, the permitting and NEPA compliance task for the second demonstration has

continued its focus on collecting general background material. Accordingly, several extensions were proposed in spring 2010 and subsequently granted: 1) D28: the Bell Creek Test Site – Environmental Questionnaire: extended from January to October 2010 and 2) D29: Permitting Action Plan: extended from March 2010 to January 31, 2011.

Second Annual PCOR Partnership Regulatory Meeting

The 2009 regulatory meeting looked at the regulatory regime associated with subsurface injection of CO_2. At the meeting held July 21–22, 2010, in Deadwood, South Dakota, there was an effort to embrace a larger community by also addressing pipelines and focusing on the efficient movement of CO_2 throughout the region. A primary goal of the meeting was to develop strategies to work past state/provincial boundaries and to establish rules and regulations outside of federal mandate. There were 22 attendees, including representatives from North Dakota, South Dakota, Missouri, Nebraska, Wyoming, Alberta, British Columbia, Saskatchewan, IOGCC, Melzer Consulting, and Carnegie Mellon University (Figure 12). The consensus of the group was to maintain its current composition for ongoing discussion purposes. However, it was recognized that the integration of additional regulatory agencies and industry representatives would provide an opportunity to discuss issues in a relatively neutral forum. A separate meeting with these groups would also serve as an opportunity to educate the individuals involved in CCS activities. It was decided to include a discussion point at the next meeting for creation of an agenda for such an educational meeting.

Task 4 – Site Characterization and Modeling

This task involves selecting the sites at which MVA activities will be designed and conducted for the two field-based large-scale demonstrations and developing baseline site characterization data and petrophysical models for the selected sites.

Figure 12. Some of the attendees at the PCOR Partnership's second annual regulatory meeting.

Activities and Results

Accomplishments during BP4, Y3 (October 1, 2009 – September 30, 2010) are described below.

Williston Basin Test Site

All activities were performed the first 2 years of Phase III when the EERC was still working under the assumption that it would have a Williston Basin test site. D30 – Geomechanical Experimental Design Package was the only deliverable completed under this subtask.

Fort Nelson Demonstration Site

The primary objective of the Fort Nelson project is to verify and validate the concept of utilizing one of North America's large number of saline formations for large-scale CO_2 injection, proposed to be up to 2 Mt a year, of anthropogenic CO_2 for permanent storage.

CSLF Recognition and Progress Reports

At its October 2009 London meeting, the CSLF recognized the Fort Nelson CCS Project as a collaborative research project that meets CSLF priorities. Subsequently, and in coordination with Spectra Energy, the PCOR Partnership submitted required project status reports on December 15, 2009; April 23, 2010; and August 20, 2010, to the CSLF Secretariat. Progress at the Fort Nelson site was reported as follows:

- Initiated an outline for the Fort Nelson MVA plan.

- In early January 2010, Spectra completed a slant drill operation conducted off the well that was drilled last year. This reentry of the borehole in the target reservoir and lower part of the cap rock extends approximately 80 meters away from the old borehole. The new borehole spans an interval from a depth of 2054 m at the top to 2283 m at the bottom. A variety of tests (well logging, leakoff tests, and water injection tests) were conducted on the well to further understand the injection target. In addition, further groundwater well samples were collected for baseline monitoring (Figure 13).

- Finalized composition of in situ brine, temperature, and pressure regime for testing and modeling programs.

- Continued running predictive modeling simulations.

- Completed significant update to static geological model.

- Completed laboratory experiments on rock-cutting samples from selected portions of core as part of an ongoing series of geomechanical and geochemistry experimental

Figure 13. Water sampling at the Fort Nelson test site (photo courtesy of Spectra Energy).

activities. These activities include the use of x-ray diffraction and scanning electron microscope techniques.

- Continued finalizing the wellhead and sandface flow conditions (i.e., temperature, pressures, density, and injected sour CO_2 stream composition) at proposed injector locations for dynamic model cases.

Additional activities involving the Fort Nelson test site included the following:

- Provided a statement of work objectives for January to December 2010 to Spectra Energy. Quarterly meetings were planned, with the first meeting scheduled for January 27, 2010, in Calgary. Monthly teleconferences have also been scheduled, with the first call planned for January 8, 2010.

- Topics discussed during conference calls included drilling update, time line/communication pathways plan, water sampling and analysis, geology update, risk assessment, project time line, the proposed Fort Nelson zone on the DSS site, and upcoming quarterly meetings.

- Numerous discussions were held between the EERC, Spectra Energy, and potential subcontractors, i.e., RPS Energy Canada and Weatherford Laboratories. Topics discussed included logistics for collecting and analyzing shallow groundwater and formation fluid samples and analytical tests on previously collected core.

- Continued update of the petrophysical model based on input gathered during meetings in Calgary in June 2010, as well as the incorporation of seismic data recently purchased by Spectra Energy.

Presentations

- Attended and participated in the PCOR Partnership annual meeting in St. Louis, Missouri, December 1–3, 2009.

- Attended the 9th Annual Conference on Carbon Capture & Sequestration in Pittsburgh, Pennsylvania (http://carbonsq.com/) and presented "A New Risk Management Methodology for Large-Scale CO_2 Storage: Application to Spectra Energy's Proposed Fort Nelson Carbon Capture and Storage Project," on May 11, 2010, in the Geologic Storage/Risk Assessment technical concurrent session.

- Attended GHGT-10 in Amsterdam, submitted a paper, and presented a poster on September 22, 2010, entitled "The Fort Nelson Carbon Capture and Storage Feasibility Project – A Program for Large-Scale Geologic Storage of CO_2 from a Natural Gas-Processing Plant in British Columbia, Canada."

Fort Nelson CCS Project Risk Management Plan (RMP)

Risk management activities have been relocated to Task 9.

Bell Creek Demonstration Site

The Bell Creek oil field in southeastern Montana has been identified as a location that may serve as a site for a PCOR Partnership Phase III demonstration. DOE NETL approved adding a new subtask to accommodate this proposed test site. A new deliverable, D87 – Geomechanical Experimental Design Package, was created for the Bell Creek site.

Additional activities involving the Bell Creek test site included the following:

- Initiated work to develop and design a laboratory experimental program for petrological, geochemical, and geomechanical analysis of core samples from the Bell Creek area.

- Discussed desired data sets and transfer protocol with the site owner/operator.

- Continued to conduct laboratory analyses of rock samples from outcrops of the Newcastle Formation in Wyoming, which are analogous to the reservoir rocks of the Bell Creek oil field, to evaluate their mineralogy and petrologic properties. These activities include the use of x-ray diffraction and scanning electron microprobe techniques.

- Continued work to develop and design a laboratory experimental program for petrological, geochemical, and geomechanical analysis of core samples from the Bell Creek area.

- In July 2010, collected samples from PRB outcrops that serve as analogs for the Bell Creek reservoir and seal (Figure 14). Toured the Bell Creek oil field in southeastern Montana. Tour highlights included the following:

  - Examined several water injection and oil production wells.

  - Obtained a keen understanding of the surface features in the Bell Creek area that must be considered when developing MVA strategies for CCS.

  - Examined an outcrop of the Cretaceous Muddy Formation, the sandstone formation that serves as the reservoir rock in the Bell Creek oil field.

- Prepared a draft version of the geomechanical work plan (D87) for the Bell Creek CCS project.

Task 5 – Well Drilling and Completion

The PCOR Partnership will work with the operator of the Bell Creek oil field to develop engineering designs for the installation of necessary injection, production, and monitoring wells.

Figure 14. Sampling at an outcrop located in the vicinity of the Bell Creek oil field.

Activities and Results

This task was scheduled to be initiated in July 2010. However, because of organizational (postacquisition integration) delays experienced by the site owner/operator, efforts in this task were initiated October 2010.

Task 6 – Infrastructure Development

This task facilitates the infrastructure planning required for CCS to be implemented on a wide-scale regional basis, as well as the development of the specific infrastructure associated with the capture, dehydration, compression, and pipeline transportation of CO_2 from its source to a Bell Creek oil field for EOR. The infrastructure development for the Bell Creek test site will be performed by the commercial partners, with EERC personnel documenting the activities, interfacing with source facility engineers and vendors, and providing assistance as needed.

Activities and Results

Accomplishments during BP4, PY3 (October 1, 2009 – September 30, 2010) included the following.

Delays in the development and deployment of the capture technology at the source for the Williston Basin demonstration necessitated the selection of a new source and injection location. Because of those circumstances, the Williston Basin demonstration project was replaced with the Bell Creek demonstration project. This represents a change from a carbon capture–compression–transportation–injection scheme to a CO_2 EOR scheme. As a result, significant changes were made to the Infrastructure Development task. Several new activities were added, including 1) maintenance and update of a capture technology "tree"; 2) provision of support for regional CO_2 compression and pipeline activities which include the preparation of a new report (D85) detailing the opportunities and challenges associated with compression and transportation during regional CCS activities with this report expected to be updated biennially; 3) preparation of a new report (D84) of a phased approach to building pipeline network for CO_2 transportation during CCS; 4) development of a "booster station calculator" for use during regional pipeline routing activities; and 5) preparation of technical briefs for new developments in capture, compression, or pipeline technologies.

Regional Infrastructure Planning

Efficient and cost-effective implementation of CCS on a wide scale will require a complete understanding of the PCOR Partnership region's infrastructure needs. It will also necessitate the development of a regional pipeline vision connecting various CO_2 sources with the most likely GS opportunities.

CO_2 Emission Sources

The PCOR Partnership maintains a CO_2 emission sources master spreadsheet that populates the data sources for the layers on the GIS portion of the partners-only Web site. Each

year, a quality assurance/quality control (QA/QC) check of the CO_2 emission sources database is conducted. The 2010 QA/QC check included the following:

- Calculating percentages of emissions from various categories within each state/ province.
- Locating Web references for CO_2 emissions from various ethanol plants, taconite plants, and refineries.
- Incorporating information that notes the vintage of the data collected.
- Resolving discrepancies in conflicting CO_2 source locations found on other Web sites.

Additional activities completed in PY3 included the following:

- Reviewed and commented on the latest draft of the CO_2 emission calculation methodology document compiled by NETL and the RCSP Capture and Transportation Working Group.
- Calculated CO_2 emissions on a lb CO_2/MWh basis for Minnesota's and North Dakota's electricity-generating facilities.
- Used the Carnegie Mellon Integrated Environmental Control Model to estimate the composition of flue gas generated by combustion of PRB subbituminous coal at an "average" subcritical power plant.
- In June 2010, provided review of a National Academy of Sciences/National Research Council comprehensive study of climate change report.
- Reviewed the U.S. Carbon Sequestration Council (USCSC) paper entitled "Prospecting for Power: The Cost of Meeting Increases in Electricity Demand."
- Provided comments on a draft USCSC paper entitled "Advances in CO_2 Sequestration Capability."

Compression

In January 2010, a draft summary of the compression process during CCS was prepared. Plans are under way to incorporate this information into the deliverable report on the opportunities and challenges associated with CO_2 compression and transportation during CCS (D85) that is due in March 2011. Additional efforts included the collection of specific operating data for various CO_2 compression technologies and performance calculations for the various compressor types.

Capture

The PCOR Partnership has nearly completed an overview of the current status of carbon capture technology development and application. The overview will cover technologies that apply to the three combustion platforms: precombustion, during combustion (oxycombustion and chemical-looping combustion), and postcombustion (Figure 15). The technologies reviewed will fall into the categories of physical and chemical absorption; physical and chemical adsorption; oxygen-, hydrogen-, and CO_2-permeable membrane processes; cryogenic processes; mineralization; and photosynthesis and chemical and biochemical reduction processes. The report will provide an overview of the technical basis for each separation technique and information on nearly 100 technologies and/or research efforts. Feedback will be requested from a small group of partners to ensure that the information is presented in a user-friendly format.

Partnership for CO_2 Capture

In an effort to share resources and thereby maximize use of DOE funding, the task leader provided support to the EERC's Partnership for CO_2 Capture (PCOC) by summarizing the capture technology overview document for inclusion in the PCOR Phase I final report and prepared PowerPoint slides summarizing the various capture technology types for use at the PCOR Partnership annual meeting held in August 2010.

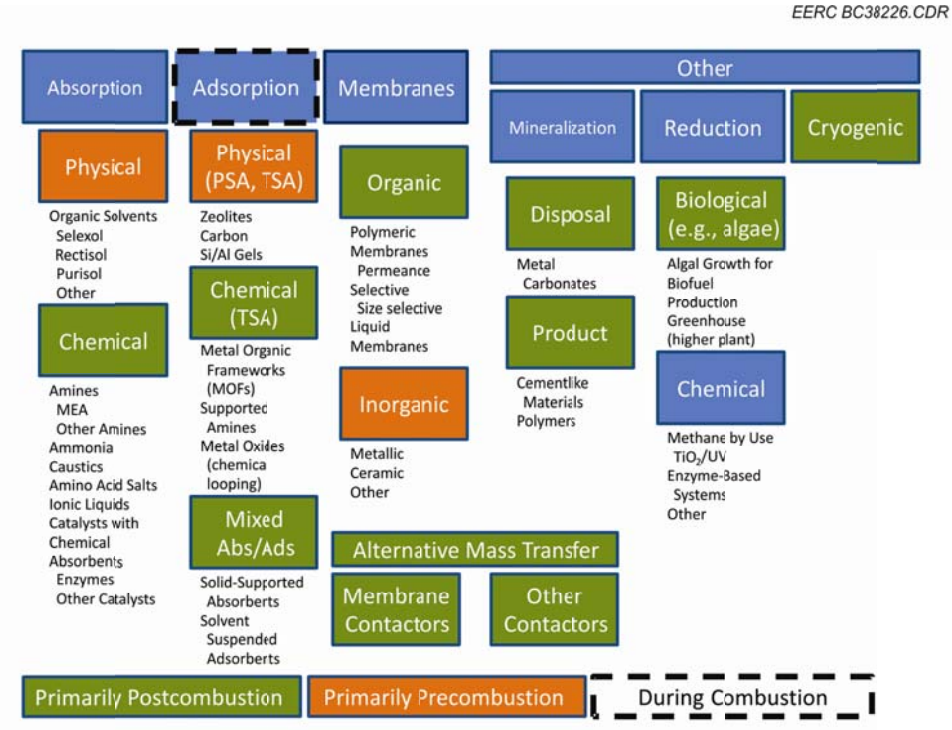


Figure 15. Carbon capture technology categories.

Additional capture activities included:

- A 36-page report containing detailed information regarding power usage, reagent costs, efficiencies, etc., for five relatively near-term, postcombustion CO_2 capture technologies, was prepared upon partner request along with a companion PowerPoint presentation.

- In March 2010, the CSLF's draft definition for the concept of "capture- and storage-ready" was reviewed and comments provided.

- Presented "Deployable CO_2 Capture Technologies" during the Carbon Management Strategies workshop held on December 1, 2009, in conjunction with the PCOR Partnership annual meeting.

Pipeline

In January 2010, a value-added report entitled "Regional Emissions and Capture Opportunities Assessment – Plains CO_2 Reduction (PCOR) Partnership" was submitted. This report replaces and updates the Phase II report of the same name and expands on it with information gathered during Phase III activities.

RCSP Pipeline Atlas Working Group (PAWG)

DOE NETL is in the process of developing a national carbon dioxide pipeline atlas that serves to highlight the state-of-the-science investigations on the development of CO_2 pipeline networks. The document will emphasize ongoing pipeline studies, compare pipeline modeling efforts, and provide visual representation of CO_2 source and sink locations throughout the United States and Canada. Similar to *Atlas III*, this new document also serves as a public outreach tool and can help readers understand the complexities associated with connecting emission sources to appropriate sinks. The working group consists of members from the RCSPs and NETL, and it will hold periodic teleconferences focused on discussing the content and format of the Pipeline Atlas, finalizing the RCSP template, and establishing a timetable for Pipeline Atlas completion.

The kickoff conference call of PAWG was held on October 21, 2009, and a second call was held in November 2009. No further action was taken or calls scheduled since that time.

Additional pipeline activities included the following:

- Completed the pipeline network routing update.

- Presented "CO_2 Pipeline Basics" at the PCOR Partnership annual meeting on December 2, 2009.

- Prepared a short text version including references of the "CO_2 Pipeline Basics" presentation given at the annual meeting. The information is being used during the

preparation of a report being authored by the IOGCC Pipeline Transportation Task Force.

- Drafted text on CO_2 pipelines for inclusion in a proposed PCOR Partnership technical brief.

Bell Creek Test Site Infrastructure Development

The PCOR Partnership will identify, catalog, and quantitatively describe the infrastructure planning required for the cost-effective distribution of CO_2 within the Bell Creek oil field injection scheme. Activities were anticipated to begin in July 2010. Postacquisition integration activities resulted in some understandable delays as time and resources were focused internally by the site owner's transition management team. Therefore, infrastructure development activities have been further delayed.

Ramgen

This subtask will evaluate the applicability of the Ramgen Power Systems compressor technology to CO_2 streams. The EERC will partner with Ramgen Power Systems, LCC, to perform these activities. Initial subcontracted activities with Ramgen ended on September 30, 2009, with the submittal of a topical report on the Preliminary Design of Advanced Compression Technology (D47). This report summarized Ramgen Power Systems activities relative to integration of the Ramgen compression technology with a power plant. Future activities with Ramgen are anticipated to reconvene in April 2011.

Presentations and Training

- Attended Optimized Gas Treating's advanced seminar focusing on the ProTreat™ simulator for acid-gas treatment held October 28–29, 2009, in Houston, Texas. The ProTreat™ software was purchased for use in PCOR Partnership technology–source matching activities, and the seminar provided the in-depth training needed to fully use this tool.

- On March 26, 2010, participated in a Webinar entitled "Gaps and Barriers to Carbon Management Technologies: Outcomes of the Founder Societies Technologies for Carbon Management Workshop." The Webinar was put on by the American Institute of Chemical Engineers; the American Institute of Mining, Metallurgical and Petroleum Engineers; the American Society of Civil Engineers; the American Society of Mechanical Engineers; and the Institute of Electrical and Electronics Engineers.

- Attended the 2010 CO_2 Capture Technology Meeting held September 13–17, 2010, in Pittsburgh, Pennsylvania.

- Attended the 9th Annual Conference on Carbon Capture and Sequestration in Pittsburgh, Pennsylvania, and presented a poster entitled "Estimating the Cost to Capture, Compress, and Transport CO_2 from Stationary Sources in the PCOR Partnership Region" during the May 11, 2010, Economics of CCS poster session.

- Presented the risks associated with capture, compression, and pipeline transportation at a risk management for CCS training seminar conducted by Oxand Risk Management Solutions and Petroleum Technology Alliance Canada on May 18, 2010, in Calgary, Alberta, Canada.

Task 7 – CO_2 Procurement

This task documents CO_2 procurement procedures for CCS and EOR activities in the PCOR Partnership region. This task provides for EERC personnel to interface with commercial partners with respect to CO_2 procurement in the region as a means of documenting critical pathways for future projects.

Activities and Results

Accomplishments during BP4, PY3 (October 1, 2009 – September 30, 2010) included the following activities facilitating a procurement plan and agreement:

- At the end of September 2009, the Bell Creek demonstration project site was selected in the PRB for the purpose of developing MVA strategies for CO_2 storage incidental to a commercial-scale EOR operation. In October 2009, discussions were under way with Encore, a long-time PCOR Partnership partner, to expedite its formal commitment to the MVA project.

- On October 31, 2009, Encore and Denbury entered into a definitive agreement providing for the merger of Encore with and into Denbury in exchange for cash and common stock. All Encore resources were redirected to acquisition studies and associated activities.

- On March 9, 2010, Denbury and Encore jointly announced that they received the requisite stockholder approval to merge Encore with and into Denbury. The combined company will continue to be known as Denbury Resources Inc. and will be headquartered in Plano, Texas. All Denbury resources were redirected to postacquisition integration, and a transitional management team, largely unfamiliar with the PCOR Partnership's activities, was created.

- Throughout the summer 2010, informal discussions between the EERC and Denbury continued, a nondisclosure agreement was drafted, and in September 2010, an invitation to present on October 13, 2010, at Denbury's headquarters in Plano, Texas, was received.

Task 8 – Transportation and Injection Operations

This task will consist of monitoring and documenting commercial partner activities related to transport of CO_2 via pipeline to the Bell Creek site as on-site injection. This task does not cover activities for the Fort Nelson site.

Activities and Results

This task was scheduled to be initiated in July 2010. However, because of organizational (postacquisition transition) delays experienced by the site owner/operator, efforts have been rescheduled to initiate October 2010.

Task 9 – Operational Monitoring and Modeling

This task will develop data sets for the large-volume CO_2 injection tests that 1) verify that injection operations do not adversely impact human health or the environment and 2) validate the storage of CO_2 for the purpose of developing an understanding of the process for monetizing carbon credits.

Activities and Results

Accomplishments during BP4, PY3 (October 1, 2009 – September 30, 2010) include the following.

Bell Creek Test Site

Activities for the Bell Creek test site were originally slated to begin in October 2010. In June 2010, initiation of activities was accelerated by 90 days to July 2010. Also, in June, DOE NETL approved the relocation of several mandatory deliverables, namely, Simulation Report (D66) and Best Practices Manual for Simulation (D69), from Task 4 to Task 9.

Activities involving the Bell Creek test site included the following:

- Conducted a field trip to visit and collect samples from several outcrops in Wyoming of rock analogous to the reservoir and cap rock in the Bell Creek oil field.

- Initiated lab testing of outcrop samples of rocks similar to the reservoir and cap rock found in the Bell Creek field (including porosity and permeability measurements, minerology and, eventually, relative permeability).

- Collected all relevant publically available data and research from the Montana Board of Oil and Gas and other public sources.

- Began the construction of a geological model of the Bell Creek oil field located in Montana.

Fort Nelson Test Site

In June, DOE NETL approved the relocation of several mandatory deliverables, namely, Simulation Report (D67) and Best Practices Manual for Simulation (D70), from Task 4 to Task 9.

Fort Nelson Test Site – Site Characterization, Modeling, and Monitoring Plan

Compilation of the site characterization, modeling, and monitoring plan (D52) will provide Spectra Energy with a cost-effective methodology which combines site characterization, modeling, risk assessment, and monitoring strategies into an iterative process to produce superior-quality results. Elements of any of these activities are crucial for understanding or developing the other activities. Although not directly involved in site characterization efforts, the EERC stands in a position to recommend additional characterization activities based on the results of modeling, measurement, and MVA evaluations.

On September 30, 2010, a draft site characterization, modeling, and monitoring plan was prepared. This document outlined the role that the EERC will play with respect to reservoir modeling and simulation, risk assessment of subsurface technical risks, and an MVA plan to address these risks. Ongoing work involves site characterization to fully define the geologic system, modeling, and simulation work to predict reservoir response to injected gas, risk assessments to identify and mitigate site security issues, and an MVA program designed to verify or detect deviations in system behavior in accordance with expectations. This process requires multiple iterations to ensure an effective, optimized, safe, and economical injection program. Currently, an initial assessment has been completed, and work is ongoing that will ultimately lead to a finalized injection strategy and affiliated risk-based MVA program.

Additional Fort Nelson test site activities included the following:

- Continued work on the porosity/permeability stochastic heterogeneous model and worked on exporting simulation data to ArcGIS for an October 2009 meeting.

- Continued geological modeling along with numerical simulations on Version 2 of the geological model to predict the fate of the injected sour CO_2.

- Continued working on Fort Nelson simulations, i.e., added new well locations and began rerunning the simulations to determine the long-term fate of the sour CO_2 with the new well locations. Recently, Spectra Energy acquired some seismic surveys in the area of interest which revealed that there may be a fault that is inhibiting flow between different portions of the study area. This has also been added to the model Version June 2010, and different fault transmissibility values are being applied to the fault in the model to determine the potential implications.

- Continued running predictive simulations on the Fort Nelson site with the new well locations, injection schemes, and fault transmissibilities.

- Continued working on predictive simulations with CO_2 injection to identify uncertainties and analyze sensitivities.

- In collaboration with Spectra Energy, continued to develop a new version of the petrophysical model (version June 2010). This version will be developed using a

number of 2-D seismic lines and several 3-D seismic surveys to better gauge the structure and properties in each zone (see Figure 16).

- Continued work on the June 2010 geological model based on refined property data sent by Spectra Energy for incorporation into the recently completed structural model.

- Continued upscaling the June 2010 static model for simulations and presented the same during the September 2010 quarterly meeting.

- Continued discussions with Spectra Energy for a special core analysis on the original test well, in addition to a geomechanical, geochemical, and a cap rock testing program for the core from the original well drilled last winter (2008–2009). The well is scheduled for reentry in January 2010. The new data from the special core analysis will be added to 2011 version of the model.

- Selected an approximate location for the next test well (which may become one of the primary injection wells) and a 3-D seismic survey—both scheduled for the winter drilling and data acquisition program. These new data will be incorporated into the 2011 version of the geological model.

- Began researching and requesting modeling software packages to aid in more accurately modeling the Fort Nelson project.

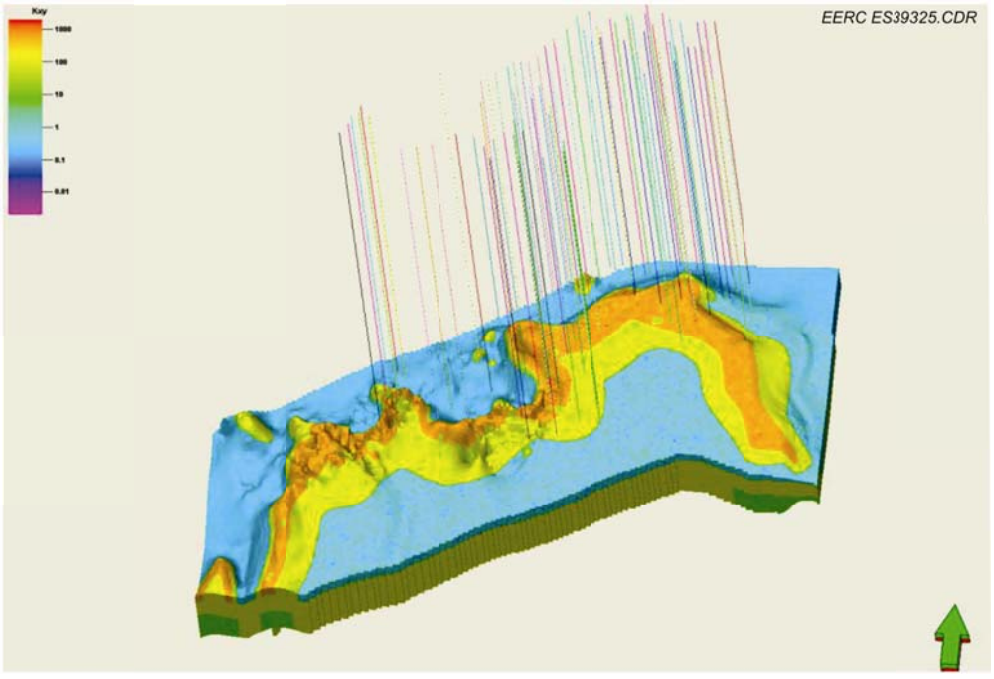


Figure 16. Well loading and simulation settings performed in Petrel for the Fort Nelson test site.

- Began researching and requesting new tools to aid in more accurately modeling the Fort Nelson project.

- Worked on numerical tuning optimization in CMOST for application to future simulation studies.

- Continued working on simulations and the development of history-matching techniques with CMOST.

- Discussed obtaining 2-D seismic lines with Spectra Energy for better formation descriptions.

- Secured updated software licenses from Schlumberger for the Petrel, ECLIPSE, and Techlog Petrophysics software for use in modeling both Phase III demonstration sites.

- In collaboration with Computer Modelling Group (CMG), testing was completed of the high-performance computing cluster to be used for improved simulation processing time.

- Participated in a conference call discussion with RPS Energy Canada (subcontractor) regarding progress on its scope of work, in particular:

  – Modeling the CO_2 heat loss down the prospective wellbore to determine what temperature it will be when it reaches the reservoir.

  – Performing some near wellbore modeling to determine the potential for thermal fracturing as a result of the injection of comparatively cold CO_2 and hot formation and formation fluids.

  – Managing the Hycal lab work for the Fort Nelson core samples, including the following tests:

    - Basic core tests
    - Relative permeability tests
    - Cap rock integrity tests
    - Geomechanical testing
    - CO_2 and H_2S solubility testing

Risk Management Activities for Fort Nelson Test Site

- Based on comments provided by Spectra Energy, modifications were initiated to the draft Risk Management Framework and First-Round Risk Assessment Results prepared in September 2009 (Figure 17).

- Submitted a second draft, along with updated appendices, of the first-round risk assessment report in January 2010.

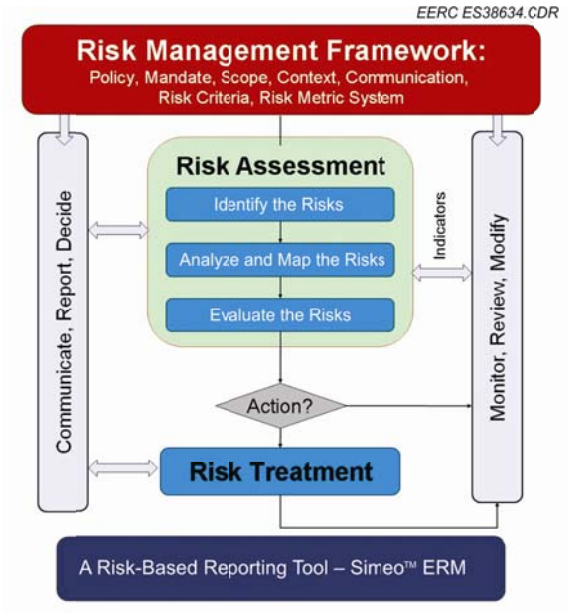


Figure 17. Risk management framework used at Fort Nelson CCS feasibility project.

- Began review of CO_2-PENS (a CO_2 sequestration systems model supporting risk-based decisions) for possible use when developing the updated risk management plan.

- Participated in a training seminar May 18–19 in Calgary, Alberta, Canada, sponsored by Oxand and Petroleum Technology Alliance Canada entitled "Risk Management for CCS Projects."

- Collaborated with Oxand on the development of a paper and poster for the GHGT-10 Conference.

- At GHGT-10, the poster entitled "A New Risk Management Methodology for Large-Scale CO_2 Storage: Application to the Fort Nelson Carbon Capture and Storage Feasibility Project" was presented by EERC staff in attendance.

RCSP Sim/Risk Working Group

The Inter-Partnership Simulation and Risk Assessment (Sim/Risk) Working Group consists of members from the RCSPs and NETL that will hold periodic teleconferences and prepare content for a best practices manual on risk assessment and simulation for geologic CO_2 storage. The purpose of this manual is to summarize and describe current best practices and protocols of simulation and risk assessment as tools for analysis of geologic CO_2 storage.

- Participated in the Sim/Risk Working Group conference calls held on a monthly, and sometimes weekly (in June and July 2010), basis.

- Simulation and risk assessment questionnaires and case histories were provided in July/August 2010 for use in the DOE best practices manual.

Presentations and Training

- Attended GHGT-10 and copresented a poster entitled "An Overview of the IEA Greenhouse Gas R&D Programme Regional Geologic Storage Capacity Studies" on September 22, 2010.

- Attended the 9th Annual Conference on Carbon Capture & Sequestration and presented "Developing Resource Estimates for CO_2 Storage in Regional Deep Saline Formations," on May 11, 2010, in the Large-Scale CCS Projects technical concurrent session.

- Attended a participatory workshop hosted by the Global Climate and Energy Project and the U.S. Geological Survey on seals and cap rocks in geologic carbon sequestration at the Asilomar Conference Grounds in Pacific Grove, California, January 12–15, 2010.

- Staff traveled to Houston, Texas, for training on CMG's CMOST and GEM. This training will help the EERC reduce model uncertainties with some new modeling software and techniques.

- Attended the IEA Greenhouse Gas R&D Programme's CO_2 Geological Storage Modeling Meeting on February 16–17, 2010, in Salt Lake City, Utah.

- Organized a training opportunity in Houston, Texas, for research staff to learn Techlog Petrophysics, a new Schlumberger petrophysical software package.

Task 10 – Site Closure

This task was not active in BP4, PY3.

Task 11 – Postinjection Monitoring and Modeling

This task was not active in BP4, PY3.

Task 12 – Project Assessment

This task communicates and disseminates all Phase III activities detailed in annual progress reports. Reports summarize program progress, accomplishments, program recognition, travel, planned activities, and goals.

Activities and Results

Assessment was conducted for the tasks during the period October 1, 2008 – September 30, 2009. A project assessment annual report (D57) was submitted on December 31, 2009.

Task 13 – Project Management

This task focuses on ensuring the overall success of the entire program by providing experienced management and leadership to each of the individual tasks and to the program as a whole. The PI and task leaders meet regularly to report the progress of their tasks and discuss any issues and corrective actions necessary. Task leaders are also responsible to provide the PI

with written weekly updates. These updates include highlights (including trip reports), issues (i.e., budget, staffing, technical issues, etc.), opportunities, and travel plans. The monthly, quarterly, and yearly updates can be found on the PCOR Partnership DSS.

Activities and Results

Accomplishments during BP4, PY3 (October 1, 2009 – September 30, 2010) include the following.

Quarterly Reports

Quarterly progress reports (D58), each including a milestone report (D59), have been submitted to DOE and the PCOR Partnership partners 1 month after the end of each calendar quarter.

Continuation Application

On June 30, 2009, the EERC submitted a continuation application (EERC Proposal No. 2009-0271) to DOE requesting BP4 funding. The proposed statement of work at that time included injecting CO_2 into saline formations in the Williston Basin in the northern Great Plains region of North America for the dual purpose of CO_2 storage and EOR. However, delays in the development and deployment of the capture technology at the source for the Williston Basin demonstration necessitated the selection of a new source and injection location. Because of those circumstances, the Williston Basin demonstration project was replaced with the Bell Creek demonstration project. The Bell Creek demonstration project will inject CO_2 captured from a gas-processing plant in central Wyoming into a saline formation in the Powder River Basin in the northern Great Plains region of North America for the purpose of developing MVA strategies for CO_2 storage incidental to a commercial-scale EOR operation. The second demonstration site, located near Fort Nelson, British Columbia, Canada, remains as planned. On April 9, 2010, a revised Phase III Continuation Application for BP4 (Program Years 3–8) was submitted to replace the June 2009 version. Revised budgets were sent on April 14, 2010, and the amended statement of program objectives was sent on April 21, 2010. In June 2010, DOE issued Modification No. 17 to the PCOR Partnership Phase II and III Cooperative Agreement No. DE-FC26-05NT42592.

The selection of the Bell Creek demonstration project also required adjustments in the initiation of certain tasks. To illustrate these adjustments, as approved by DOE, a second-level Gantt Chart is depicted in Figure 18.

Project Management Plan

On July 14, 2009, the updated project management plan (D63) including a preliminary RMP (D77) was submitted. In July 2010, a discussion was held with the DOE NETL project manager, and it was determined that modification to certain sections of the reporting format were in order. Subsequently, efforts have been undertaken to revise the format and update the plan as appropriate.

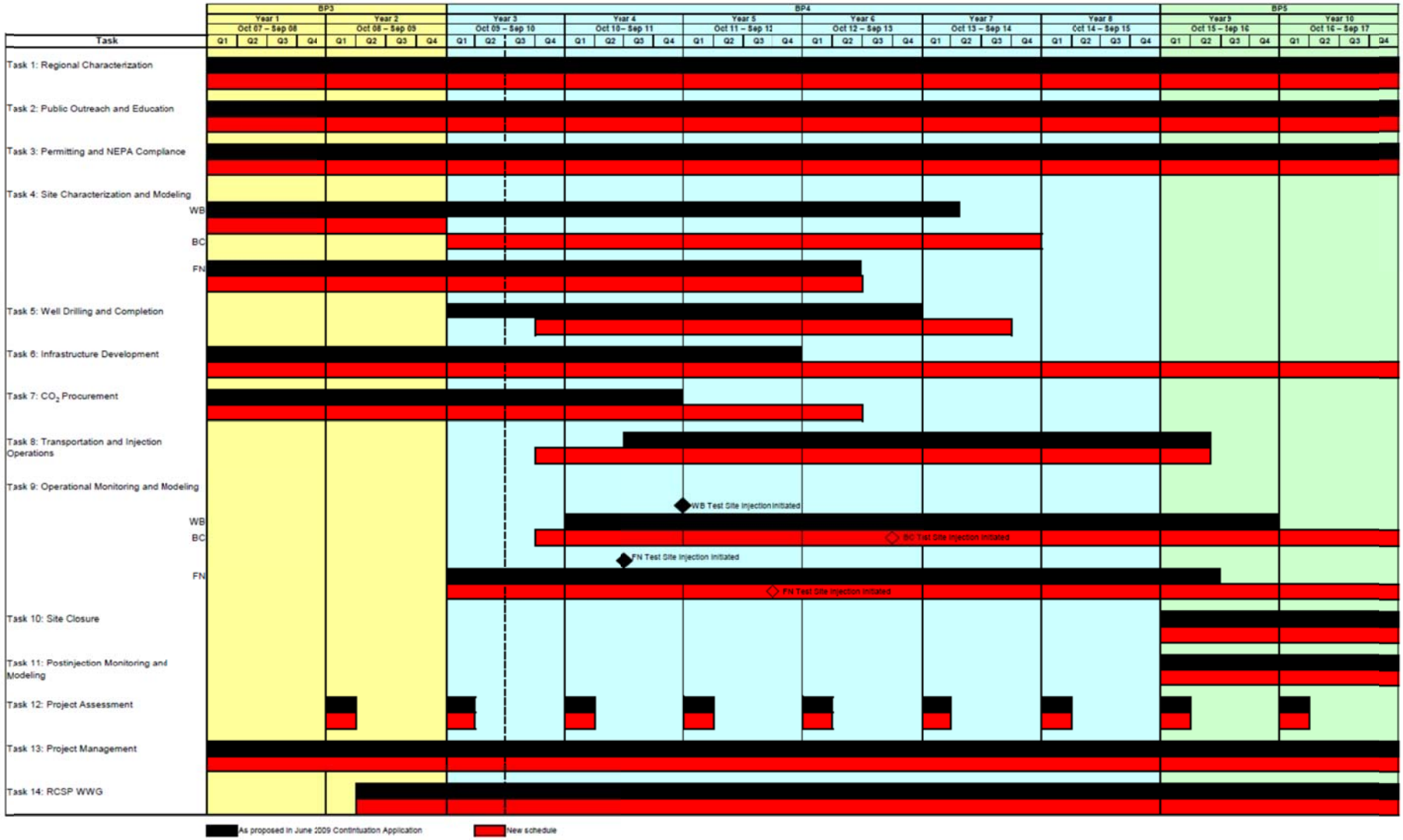


Figure 18. Comparison of PCOR Partnership 2009 time line and 2010 revised time line.

Annual Meetings

The 2009 PCOR Partnership Annual Meeting (Figure 19) was held in St. Louis, Missouri, on December 2–3, 2009, with workshops on Effective Outreach and Carbon Management Strategies held December 1. The overriding theme of the meeting was "Carbon Management 2010: The Push Toward Commercialization." The meeting attracted 84 attendees representing 50 organizations from 15 states, five Canadian provinces, and two foreign countries.

The 2010 PCOR Partnership Annual Meeting (Figure 20) will be held in Minneapolis, Minnesota, on October 20–21, 2010. On October 19, a premeeting workshop will feature an interactive group exercise where participants, using Implications Wheel® software, will identify the implications of conducting an EOR and saline geologic sequestration project. Participants will also identify opportunities and challenges associated with each project.

RCSP Support

- The PCOR Partnership was asked to coordinate the RCSP WWG. In December 2008, a proposal to add this new task was submitted to DOE. This task began Quarter 2 – BP3, Year 2, and is ongoing through 2017.

- The PCOR Partnership participated in the RCSP annual review meeting held November 16–19, 2009, in Pittsburgh, Pennsylvania. Four oral presentations were given, four posters were presented, four fact sheets were prepared, and staff participated in several working group side meetings.

- Members of the GIS, Capture and Transportation, Geologic, Outreach, and Risk Assessment Working Groups took part in monthly conference calls.

- The PCOR Partnership's PI serves as Chairman for the North American Energy Working Group's (NAEWG's) Subcommittee on CO_2 Storage Capacity Estimation, also known as the Methodology Subcommittee. This subcommittee discusses geologic storage capacity coefficients and the methodology for estimations. The data sharing of this group will lead to a solid foundation in the area of CO_2 capture and sequestration mapping and estimations in North America. This subcommittee coordinates its activities closely with the NAEWG–North American Carbon Atlas Partnership (NACAP). In PY3, the Methodology and IT subcommittees worked on the level of detail/granularity in a publicly accessible GIS system. The PI also participated in the NACAP meeting held in Cuernavaca, Mexico, in March 2010.

Figure 19. The 2009 annual meeting banner.

Figure 20. The 2010 annual meeting banner.

- CCS is one of the topics that both the United States and Canada have expressed interest in to continue discussions. The Workshop on Potential Joint CCS Projects with Canada under the Clean Energy Dialogue was held on June 29–30, 2009, in Washington, D.C. This is occurring under the U.S.–Canada Clean Energy Dialogue. From the U.S. side, the effort is being led by the DOE Office of Policy and International Affairs. On May 10, 2010, preceding the 9th Annual CCS Conference, PCOR Partnership staff attended and participated in the 2010 U.S.–Canada Clean Energy Dialogue Bilateral National Conference, Pittsburgh, Pennsylvania.

DOE Fossil Energy Techlines

- A DOE Fossil Energy Techline "'Sour' Gas Streams Safe for Carbon Sequestration, DOE-Sponsored Study Shows" was posted online September 23, 2010. This Techline reported that the Zama Acid Gas EOR, CO_2 Storage, and Monitoring Project demonstrated that gas streams containing high levels of both CO_2 and hydrogen sulfide can be safely used for CCS.

- A DOE Fossil Energy Techline "DOE Regional Partnership Successfully Demonstrates Terrestrial CO_2 Storage Practices in Great Plains Region of U.S. and Canada" was posted on August 19, 2010. This Techline reported that the PCOR Partnership successfully demonstrated the best approaches for terrestrial carbon dioxide storage in the Prairie Pothole Region.

- A DOE Fossil Energy Techline "DOE-Sponsored Field Test Demonstrates Viability of Simultaneous CO_2 Storage and Enhanced Oil Recovery in Carbonate Reservoirs" was posted on June 28, 2010. This Techline reported that the Northwest McGregor field validation test successfully demonstrated that using CO_2 in an EOR method dubbed huff 'n' puff can help assess the carbon storage potential of geologic formations.

Annual Carbon Capture & Sequestration Conference

The PCOR Partnership took part in the 9th Annual Carbon Capture & Sequestration Conference held May 10–13, 2010, in Pittsburgh, Pennsylvania. Eighteen abstracts were submitted, with 17 accepted, of which one was declined, and one rejected. All told, over the

course of 2 days, 13 oral presentations were given, and three posters were presented by the PCOR Partnership. Three papers were also submitted.

International Conference on Greenhouse Gas Control Technologies

The GHGT conference series has established itself as the principal international conference on GHG mitigation technologies especially on CCS. The IEA Greenhouse Gas R&D Programme (IEA GHG) is the guardian of the conference series. The GHGT conferences are held every 2 years in IEA GHG member countries. The conference series rotates between North America, Europe and Asia.

The PCOR Partnership submitted ten abstracts on or before the GHGT-10 deadline in December 2009. In May 2010, it received notification that all ten of its abstracts were accepted: two for oral presentations and eight for poster presentations. Ten papers were submitted by the PCOR Partnership before the deadline in August 2010. All papers presented as either an oral or poster presentation and accompanied by a copyright transfer form will be published by Elsevier online in its Energy Procedia in spring 2011; no differentiation will be made in the proceedings between oral and poster papers.

The PCOR Partnership participated in GHGT-10 along with 1600 delegates representing 55 countries. There were 259 oral presentations, including two presented by the PCOR Partnership, and 760 posters, including eight presented by the PCOR Partnership.

Miscellaneous Activities

- The EERC's Partnership for CO_2 Capture, an 18-month project that examines the feasibility of different CO_2 capture technologies, was initiated on March 26, 2008. This project will complement various EERC PCOR Partnership activities. In August 2010, the PI presented information on the PCOR Partnership at the Partnership for CO_2 Capture Phase II Kickoff Meeting.

- The draft outline for the RMP (D77) was submitted to DOE at the end of BP3 for review. The RMP is a living document, and more progress will be made as each Phase III demonstration project evolves.

PCOR Partnership Partners

The PCOR Partnership has significant support and participation from its partners. As of September 30, 2010, 89 partners are supporting Phase III activities. Phase II members in good standing were automatically considered members of Phase III for the overlapping program years (October 1, 2007 – September 30, 2009).

- New partners:
  - Indian Land Tenure Foundation (December 2009)
  - Aquistore Project (led by PTRC – University of Regina) (September 2010)
  - British Columbia Oil and Gas Commission (September 2010)
  - Wyoming Office of State Lands and Investments (August 2010)

Task Leader Meetings

Approximately once a month a meeting is held with all the task leaders, PI/program manager, budget personnel, and support staff. These meetings are convened in order to share information, create time lines for the completion of products, and disseminate data.

Lignite Energy Council Award

In October 2009, the North Dakota Lignite Energy Council's Awards Committee presented Ed Steadman and John Harju with the "Distinguished Service – Research and Development Award" because of their leadership and counsel on CO_2 storage projects involving the lignite industry. The awards were presented during the Lignite Energy Council's annual meeting in Bismarck, North Dakota.

Carbon Sequestration Leadership Forum

The CSLF promotes collaborative research, development, and demonstration projects that reflect members' priorities. The CSLF may recognize collaborative projects that facilitate the development of improved cost-effective technologies for the separation and capture of carbon dioxide for its transport and long-term safe storage, make these technologies broadly available internationally, and identify and address wider issues relating to CCS. The project was granted CSLF recognition and is one of 30 such projects formally recognized. As of September 30, 2010, the PCOR Partnership is the only regional partnership to have received project recognition for not only one project, but two (note: the Zama Acid Gas EOR, CO_2 Storage, and Monitoring Project received recognition in 2007).

In June 2010, the PI accepted an invitation to join the Storage Working Group created under the new CSLF Technical Group Task Force on "Assessing the Progress in Closing the Gaps." Comments were submitted to the working group leader in July 2010. Upon group agreement on a final list of gaps, an assessment will be conducted to determine whether progress have been made in the last year to close any particular gap.

Task 14 – RCSP Water Working Group Coordination

In order to investigate the relationship between water and CCS, members of the RCSPs have formed the WWG. Each RCSP has its own unique set of challenges related to water utilization and the implementation of CCS activity, and the WWG will help to address those concerns. The PCOR Partnership leads an RCSP WWG comprising appropriate stakeholders. The RCSP WWG was initiated in January of 2009. The purpose of the WWG is to address the wide variety of concerns and opportunities at the nexus of carbon storage and water resources. Development of documents under this task is led by the EERC, with input from all WWG participants.

Activities and Results

Accomplishments during this assessment period (October 1, 2009 – September 30, 2010) include the following.

Monthly Conference Calls

A total of 15 monthly conference calls (M23) have taken place overall, ten of which were completed in PY3, as follows: October 26, 2009; November 16, 2009; January 6, 2010; February 25, 2010; March 23, 2010; April 28, 2010; May 13, 2010; June 23, 2010; July 28, 2010; and August 31, 2010. DOE NETL waived the requirement for December 2009 and September 2010 conference calls. Minutes of the calls are submitted to the WWG the subsequent month following a call.

Annual Meetings

The second annual WWG meeting (M24) was held on May 13, 2010, in Pittsburgh, Pennsylvania, following the conclusion of the 9th Annual CCS Conference. The group discussed conducting a road-mapping exercise during a future conference call and also made plans for the development of a path forward for the group as a whole.

Methodology Document

A methodology document (D79) to estimate the resource that might be available in different reservoirs will be generated as storage projects are developed. Because of the lack of water produced in current RCSP storage projects, on December 15, 2009, DOE waived the requirement for water resource estimation methodology documents originally due February 2010 and May 2011. The fact sheet submitted April 30, 2010, replaced the former (see below). An alternative report to replace the latter is still under consideration.

WWG Fact Sheet

In lieu of the water resource estimation methodology document originally due in February 2010, a 1-page fact sheet (front and back) was developed providing an overview of issues and opportunities associated with the nexus of water and CCS. The WWG coordinated its efforts with the OWG to produce a fact sheet that was loosely based on the white paper (D78). WWG comments were received in March 2010, and the final fact sheet was submitted as a value-added product on April 30, 2010. On May 10, 2010, at the 9th Annual CCS Conference, the WWG fact sheet was released publicly.

White Paper on Nexus of CCS and Water

The WWG will provide input into a DOE white paper on the nexus of CCS and water to include the conditions under which waters would be produced, a description of the produced waters, and a summary of their potential uses and water treatment needs for reuse. The life cycle cost of water management in conjunction with CCS will also be examined. The final White Paper on the Nexus of CCS and Water (D78) was submitted on October 28, 2009 (Figure 21).

WWG PowerPoint Presentation

The WWG determined that creation of a canned or ready-to-use PowerPoint presentation (Figure 22) that could be given by any or all of the participants would encourage presentation of

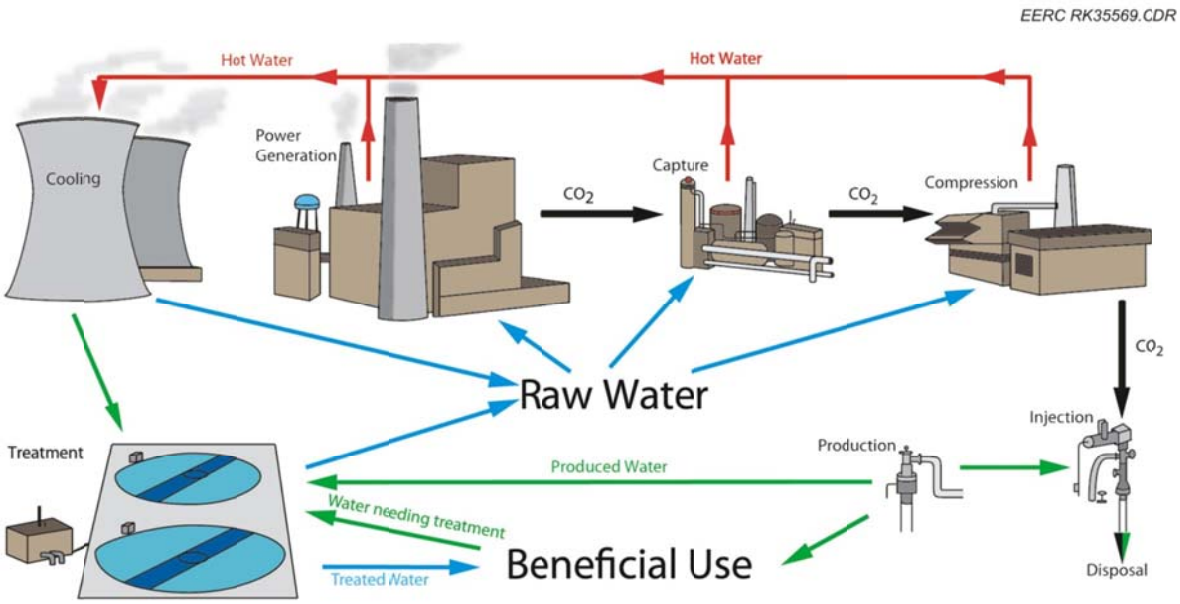


Figure 21. The nexus of CO_2 and water results in water usage at carbon sources and potential production and beneficial use near storage sites.

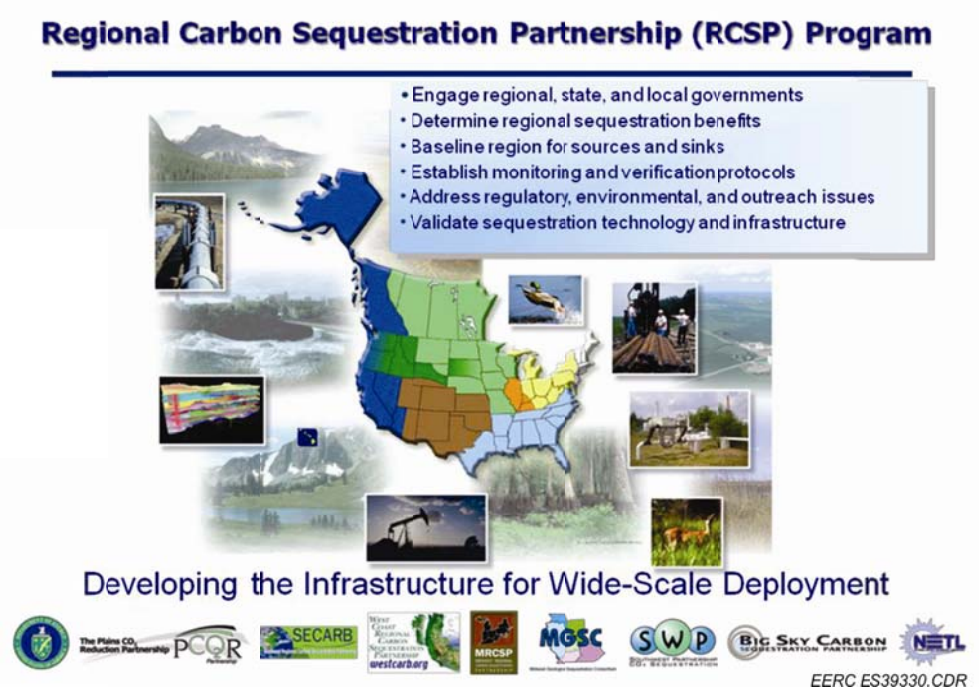


Figure 22. Slide excerpted from the WWG ready-to-use PowerPoint presentation.

its efforts at a variety of conferences, meetings, and events. PCOR Partnership staff presented the WWG PowerPoint presentation at the AAPG Geosciences Technology Workshop on Carbon Capture and Sequestration in Golden, Colorado, on August 12, 2010.

Miscellaneous Activities

- On November 13, 2009, created a listing of Future Research Ideas Related to CCS.
- Participated in a joint WWG and OWG meeting on November 16, 2009, in Pittsburgh.
- Initiated compilation of a list of potential stakeholder groups that would be interested in the nexus of water and CCS (some of these groups may be contacted by WWG and participate in a single call addressing their concerns).
- Created a WWG mission statement.
- Attended the Groundwater Protection Council 2010 UIC Conference held in Austin, Texas, on January 25–27, 2010. Served on an RCSP panel and provided an update on the PCOR Partnership on January 27, 2010.
- Attended the 9th Annual Conference on Carbon Capture & Sequestration and presented "Regional Carbon Sequestration Partnership: Water Working Group" on May 11, 2010, in the Water Resources and CCS technical concurrent session.
- Initiated preliminary planning to expand task objectives to include a matchup of quality and quantity of produced water with potential end users, along with an economic analysis to test the viability of producing water along with CCS.

COST STATUS

The currently approved budget for Phase III is shown in Table 3.

Table 3. PCOR Partnership Phase III Budget (as of 9/30/10)

	BP3 Year 1 – Year 2 10/1/07 – 9/30/09		BP4 Year 3 – Year 8 10/1/09 – 9/30/15		BP5 Year 9 – Year 10 10/1/15 – 9/30/17		Total	
DOE Share*	$ 5,709,149	62.0%	$ 53,990,663	73.2%	$ 9,668,307	80.0%	$ 69,368,119	72.9%
Nonfederal Cost Share								
Cash**	$ 887,428		$ 2,411,971		$ -		$ 3,299,399	
Noncash	$ 2,613,890		$ 17,400,865		$ 2,417,076		$ 22,431,831	
Total Nonfederal Cost Share	$ 3,501,318	38.0%	$ 19,812,836	26.8%	$ 2,417,076	20.0%	$ 25,731,230	27.1%
Total Revised Budget	**$ 9,210,467**	**100%**	**$ 73,803,499**	**100%**	**$ 12,085,383**	**100%**	**$ 95,099,349**	**100%**

* Includes $1.5M in BP3 for an EIS analysis to be contracted directly by DOE should it be necessary.
** Cash as recognized by DOE.

On September 30, 2010, the PCOR Partnership completed its first year of BP4 activities (PY3, October 1, 2009 – September 30, 2010). Actual cash expenditures of DOE and nonfederal sources, as well as noncash cost share reported through September 30, 2010, are listed in Table 4. A graph depicting the cost plan vs. actual expenses for the first two years of BP4 (October 1, 2009 – September 30, 2011) is shown in Figure 23. The cost plan for PY4 is based on the currently approved budget.

SCHEDULE STATUS

Table 5 contains all of the Phase III deliverables, milestones, and submission dates for the reporting period. Table 6 provides a Gantt chart for BP4.

Table 4. BP4 Funding

Organization	Approved Budget, $	Actual Costs Incurred, $
DOE Share – Cash	53,990,663	4,708,998
Nonfederal Share – Cash	2,411,971	416,300
Nonfederal Share – In-Kind	17,400,865	11,751,352
Total	73,803,499	16,876,650

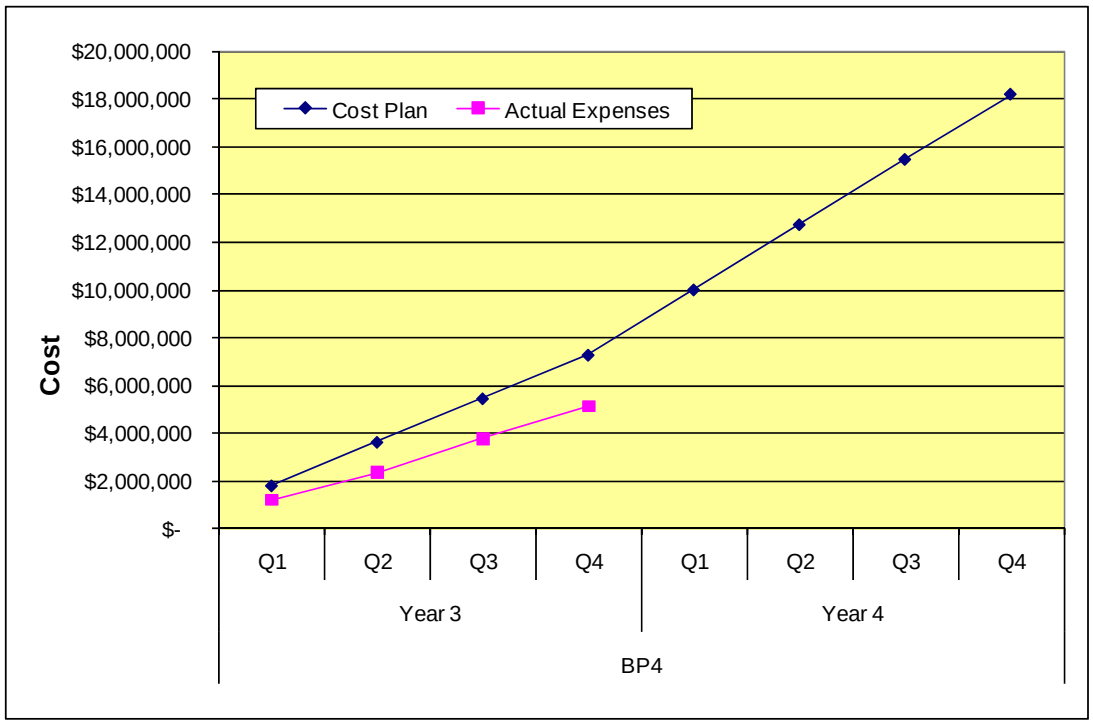


Figure 23. Cost plan vs. actual expenses.

Table 5. Phase III Milestones and Deliverables

Title/Description	Due Date	Actual Completion Date
Year 1 – Quarter 1 (October–December 2007)		
D37: Task 4 – Fort Nelson Test Site – Geological Characterization Experimental Design Package	12/31/07	12/28/07
D63: Task 13 – Project Management Plan	12/31/07	12/28/07
M17: Task 4 – Fort Nelson Test Site Selected	12/31/07	12/28/07
Year 1 – Quarter 2 (January–March 2008)		
D38: Task 4 – Fort Nelson Test Site – Geomechanical Experimental Design Package	1/31/08	1/31/08
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	1/31/08	1/31/08
D11: Task 2 – Outreach Plan	3/31/08	3/31/08
D27: Task 3 – Environmental Questionnaire – Fort Nelson Test Site	3/31/08	4/02/08
D30: Task 4 – Williston Basin Test Site – Geomechanical Experimental Design Package	3/31/08	3/31/08
M1: Task 1 – Three Target Areas Selected for Detailed Characterization	3/31/08	3/20/08
M18: Task 4 – Fort Nelson Test Site Geochemical Work Initiated	3/31/08	3/19/08
Year 1 – Quarter 3 (April–June 2008)		
D14: Task 2 – General Phase III Fact Sheet	4/30/08	4/30/08
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	4/30/08	4/30/08
D17: Task 2 – General Phase III Information PowerPoint Presentation	5/30/08	5/30/08
M3: Task 3 – Start Environmental Questionnaire for Williston Basin Test Site	6/30/08	6/27/08
M6: Task 4 – Williston Basin Test Site Geochemical Work Initiated	6/30/08	6/30/08
M7: Task 4 – Williston Basin Test Site Geological Characterization Data Collection Initiated	6/30/08	6/30/08
Year 1 – Quarter 4 (July–September 2008)		
D12: Task 2 – Demonstration Web Pages on the Public Site	7/31/08	7/31/08
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	7/31/08	7/31/08
D1: Task 1 – Review of Source Attributes	9/30/08	9/26/08
M2: Task 1 – Demonstration Project Reporting System (DPRS) Prototype Completed	9/30/08	9/26/08
Year 2 – Quarter 1 (October–December 2008)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	10/31/08	10/31/08
D20: Task 2 – Documentary Support to PowerPoint and Web Site	12/31/08	12/31/08
D57: Task 12 – Project Assessment Annual Report	12/31/08	12/31/08

Continued . . .

Table 5. Phase III Milestones and Deliverables (continued)

Title/Description	Due Date	Actual Completion Date
Year 2 – Quarter 2 (January–March 2009)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	1/31/09	1/30/09
M21: Task 14 – Outline of White Paper on Nexus of CO_2 Capture and Sequestration (CCS) and Water, Part Subtask 14.2 – White Paper on Nexus of CCS and Water	2/28/09	2/27/09
D24: Task 2 – PCOR Partnership Region Sequestration General Poster	3/31/09	3/31/09
Year 2 – Quarter 3 (April–June 2009)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	4/30/09	4/30/09
M23: Task 14 – Monthly WWG Conference Call Held	4/30/09	4/15/09
D2: Task 1 – First Target Area Completed	5/29/09	5/29/09
M23: Task 14 – Monthly WWG Conference Call Held	5/29/09	5/29/09
D16: Task 2 – Fort Nelson Test Site Fact Sheet	5/29/09	5/29/09
M24: Task 14 – WWG Annual Meeting Held	5/31/09	5/07/09
M23: Task 14 – Monthly WWG Conference Call Held	6/30/09	6/25/09
Year 2 – Quarter 4 (July–September 2009)		
M23: Task 14 – Monthly WWG Conference Call Held	N/A	Not required
D19: Task 2 – Fort Nelson Test Site PowerPoint Presentation	7/31/09	7/31/09
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	7/31/09	7/31/09
M22: Task 14 – Draft White Paper – Nexus of CCS and Water Available for Comments	8/17/09	8/18/09 (DOE) 8/21/09 (WWG)
M23: Task 14 – Monthly WWG Conference Call Held	8/31/09	8/25/09
D1: Task 1 – Review of Source Attributes	9/30/09	9/25/09
D3: Task 1 – Permitting Review – One State and One Province	9/30/09	9/30/09
D9: Task 1 – Updated DSS	9/30/09	9/29/09
D47: Task 6 – Report on the Preliminary Design of Advanced Compression Technology	9/30/09	9/30/09
D77: Task 13 – Risk Management Plan Outline	9/30/09	9/18/09
M4: Task 4 – Bell Creek Test Site Selected	9/30/09	9/30/09
M5: Task 4 – Bell Creek Test Site – Data Collection Initiated	9/30/09	9/30/09
M23: Task 14 – Monthly WWG Conference Call Held	9/30/09	9/22/09

Continued . . .

Table 5. Phase III Milestones and Deliverables (continued)

Title/Description	Due Date	Actual Completion Date
Year 3 – Quarter 1 (October–December 2009)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	10/30/09	11/02/09
D78: Task 14 – Final White Paper on the Nexus of CCS and Water	10/30/09	10/28/09
M23: Task 14 – Monthly WWG Conference Call Held	10/31/09	10/26/09
M23: Task 14 – Monthly WWG Conference Call Held	11/30/09	11/16/09
D57: Task 12 – Project Assessment Annual Report	12/31/09	12/31/09
M23: Task 14 – Monthly WWG Conference Call Held	12/31/09	Waived by DOE
Year 3 – Quarter 2 (January–March 2010)		
D13: Task 2 – Public Site Updates	1/15/10	1/15/10
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	1/31/10	1/29/10
M23: Task 14 – Monthly WWG Conference Call Held	1/31/10	1/6/10
D79: Task 14 – Water Resource Estimation Methodology Document	2/28/10	Waived by DOE
M23: Task 14 – Monthly WWG Conference Call Held	2/28/10	2/25/10
D11: Task 2 – Outreach Plan	3/31/10	3/31/10
M23: Task 14 – Monthly WWG Conference Call Held	3/31/10	3/23/10
Year 3 – Quarter 3 (April–June 2010)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	4/30/10	4/30/10
M23: Task 14 – Monthly WWG Conference Call Held	4/30/10	4/28/10
M23: Task 14 – Monthly WWG Conference Call Held	5/31/10	5/13/10
D17: Task 2 – General Phase III Information PowerPoint Presentation (update)	6/30/10	6/30/10
D19: Task 2 – Fort Nelson Test Site PowerPoint Presentation (update)	6/30/10	6/29/10
M23: Task 14 – Monthly WWG Conference Call Held	6/30/10	6/23/10
M24: Task 14 – WWG Annual Meeting Held	6/30/10	5/13/10

Continued . . .

Table 5. Phase III Milestones and Deliverables (continued)

Title/Description	Due Date	Actual Completion Date
Year 3 – Quarter 4 (July–September 2010)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	7/31/10	7/29/10
M23: Task 14 – Monthly WWG Conference Call Held	7/31/10	7/28/10
M23: Task 14 – Monthly WWG Conference Call Held	8/31/10	8/31/10
D1: Task 1 – Review of Source Attributes	9/30/10	9/20/10
D52: Task 9 – Fort Nelson Test Site – Site Characterization, Modeling, and Monitoring Plan	9/30/10	9/30/10
M9: Task 4 – Bell Creek Test Site Geological Model Development Initiated	9/30/10	9/30/10
M23: Task 14 – Monthly WWG Conference Call Held	9/30/10	Waived by DOE
Year 4 – Quarter 1 (October–December 2010)		
D87: Task 4 – Bell Creek Test Site – Geomechanical Experimental Design Package	10/30/10	
D15: Task 2 – Bell Creek Test Site Fact Sheet	10/31/10	
D28: Task 3 – Environmental Questionnaire – Bell Creek Test Site	10/31/10	
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	10/31/10	
M23: Task 14 – Monthly WWG Conference Call Held	10/31/10	
D31: Task 4 – Bell Creek Test Site – Geological Characterization Experimental Design Package	11/30/10	
M23: Task 14 – Monthly WWG Conference Call Held	11/30/10	
M28: Task 4 – Bell Creek Geological Experimental Design Package Completed	11/30/10	
D57: Task 12 – Project Assessment Annual Report	12/31/10	
M23: Task 14 – Monthly WWG Conference Call Held	12/31/10	

Continued . . .

Table 5. Phase III Milestones and Deliverables (continued)

Title/Description	Due Date	Actual Completion Date
Year 4 – Quarter 2 (January–March 2011)		
M8: Task 4 – Bell Creek Test Site Wellbore Leakage Data Collection Initiated	1/15/11	
D29: Task 3 – Permitting Action Plan	1/31/11	
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	1/31/11	
M23: Task 14 – Monthly WWG Conference Call Held	1/31/11	
D65: Task 4 – Fort Nelson Test Site – Site Characterization Report	2/28/11	
M23: Task 14 – Monthly WWG Conference Call Held	2/28/11	
M29: Task 4 – Fort Nelson Site Characterization Report completed	2/28/11	
D10: Task 1 – Demonstration Project Reporting System Update	3/31/11	
D18: Task 2 – Bell Creek Test Site PowerPoint Presentation (update)	3/31/11	
D26: Task 2 – Fort Nelson Test Site Poster	3/31/11	
D85: Task 6 – Report – Opportunities and Challenges Associated with CO_2 Compression and Transportation During CCS Activities	3/31/11	
M23: Task 14 – Monthly WWG Conference Call Held	3/31/11	
Year 4 – Quarter 3 (April–June 2011)		
M30: Task 5 – Bell Creek Test Site Baseline MVA Initiated	4/01/11	
M23: Task 14 – Monthly WWG Conference Call Held	4/30/11	
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	4/30/11	
D17: Task 2 – General Phase III Information PowerPoint Presentation (update)	5/31/11	
D34: Task 4 – Bell Creek Test Site – Baseline Hydrogeological Final Report	5/31/11	
M23: Task 14 – Monthly WWG Conference Call Held	5/31/11	
D19: Task 2 – Fort Nelson Test Site PowerPoint Presentation (update)	6/30/11	
D60: Task 13 – Site Development, Operations, and Closure Plan	6/30/11	
M23: Task 14 – Monthly WWG Conference Call Held	6/30/11	
M24: Task 14 – WWG Annual Meeting Held	6/30/11	

Continued . . .

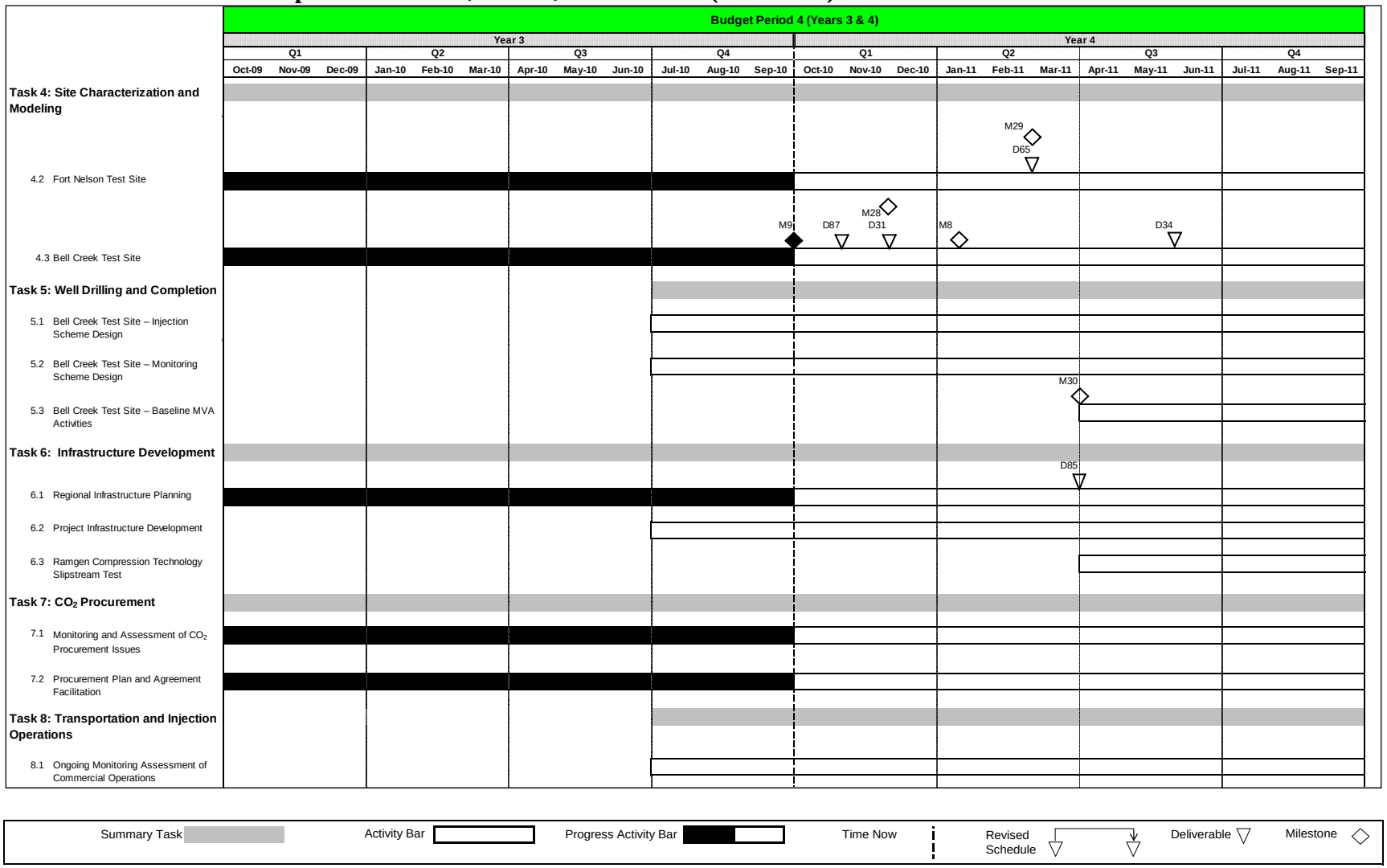
Table 5. Phase III Milestones and Deliverables (continued)

Title/Description	Due Date	Actual Completion Date
Year 4 – Quarter 4 (July–September 2011)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	7/31/11	
M23: Task 14 – Monthly WWG Conference Call Held	7/31/11	
D81: Task 1 – Regional Carbon Sequestration Atlas (update)	8/31/11	
M23: Task 14 – Monthly WWG Conference Call Held	8/31/11	
D1: Task 1 – Review of Source Attributes	9/30/11	
D4: Task 1 – Permitting Review – Two Additional States	9/30/11	
D9: Task 1 – Updated DSS	9/30/11	
D25: Task 2 – Bell Creek Test Site Poster	9/30/11	
D50: Task 9 – Bell Creek Test Site – Site Characterization, Modeling, and Monitoring Plan	9/30/11	
M23: Task 14 – Monthly WWG Conference Call Held	9/30/11	
M31: Task 9 – Bell Creek Test Site – Site Characterization, Modeling, and Monitoring Plan Completed	9/30/11	

Table 6. PCOR Partnership Phase III BP4, PY3–4, Gantt Chart

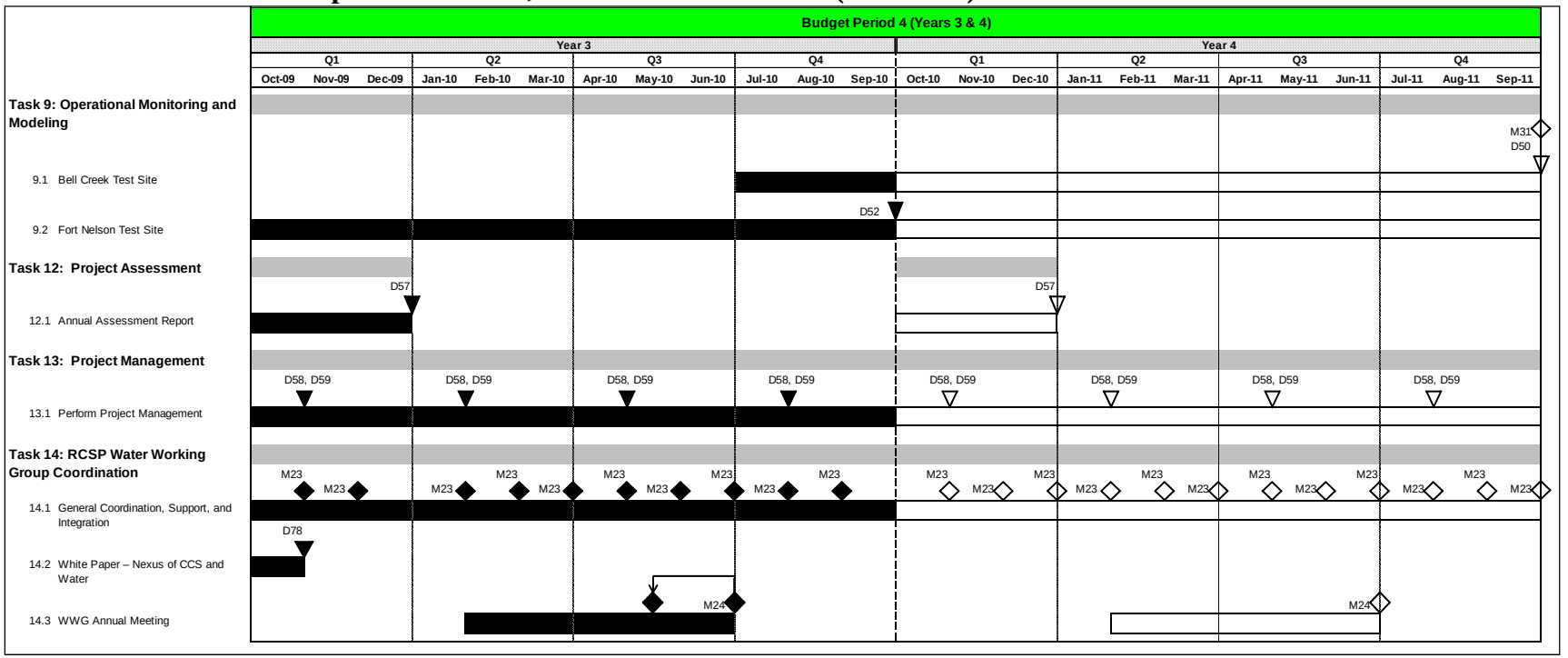
Continued…

Table 6. PCOR Partnership Phase III BP4, PY3–4, Gantt Chart (continued)



Continued…

Table 6. PCOR Partnership Phase III BP4, Years 3–4 Gantt Chart (continued)



Key for Deliverables (D)			
D1	Review of Source Attributes	D29	Permitting Action Plan
D4	Permitting Review – Two Additional States	D31	BC Test Site – Geological Characterization Experimental Design Package
D9	Updated DSS	D34	BC Test Site – Baseline Hydrogeological Experimental Design Package
D10	DPRS Update	D50	BC Test Site – Site Characterization, Modeling, and Monitoring Plan
D11	Outreach Plan	D52	FN Test Site – Site Characterization, Modeling, and Monitoring Plan
D13	Public Site Updates	D57	Project Assessment Annual Report
D15	Bell Creek (BC) Test Site Fact Sheet	D58	Quarterly Progress Report
D16	Fort Nelson (FN) Test Site Fact Sheet	D59	Milestone Quarterly Report
D17	General Phase III Information PowerPoint Presentation	D65	FN Test Site – Site Characterization Report
D19	FN Test Site PowerPoint Presentation	D78	White Paper – Nexus of CCS and Water
D20	Video Support to PowerPoint and Web Site	D81	Regional Carbon Sequestration Atlas (update)
D24	PCOR Partnership Region CO_2 Storage General Poster	D85	Report – Opportunities and Challenges Associated with CO_2 Compression and Transportation During CCS Activities
D25	BC Test Site Poster		
D26	FN Test Site Poster	D87	BC Test Site – Geomechanical Experimental Design Package
D28	BC Test Site – Environmental Questionnaire		

Key for Milestones (M)	
M8	BC Test Site – Wellbore Leakage Data Collection Initiated
M9	BC Test Site – Geological Model Development Initiated
M23	Monthly WWG Conference Call Held
M24	WWG Annual Meeting Held
M28	BC Test Site – Geological Characterization Experimental Design Package Completed
M29	FN Test Site – Site Characterization Report Completed
M30	BC Test Site – Baseline MVA Activities Initiated
M31	BC Test Site – Site Characterization, Modeling, and Monitoring Plan Completed

PLANNED ACTIVITIES

Task 1 – Regional Characterization

During the next program year (October 1, 2010 – September 30, 2011), the following activities will be undertaken:

- Review and update attribute data for existing sources. Add additional attributes as necessary for characterization. Incorporate new sources as they come online (D1).

- Continue to refine storage analogs for specific geologic horizons within the regional basins, including the northern Great Plains basal aquifer system. In summer 2010, discussions were under way for a binational (Canada–United States), multiprovincial–multistate (Alberta, Saskatchewan, Manitoba, North Dakota, South Dakota), multiorganizational project. It will soon be proposed that the PCOR Partnership and Alberta Innovates Technology Futures (AITF) participate in a 3-year project aimed at determining the CO_2 storage capacity of the Basal Cambrian saline formation system. In order to effectuate better management control of this characterization, plans are under way to request approval from DOE NETL to create a separate task for the more detailed Basal Cambrian work.

- Continue ongoing efforts at the Zama Acid Gas EOR, CO_2 Storage, and Monitoring Project. In order to effectuate better management control of this project, plans are under way to request approval from DOE NETL to create a separate task for the ongoing Zama work.

- Work with the geological surveys/oil and gas divisions of the states and provinces to develop greater detail of the field and reservoir data.

- Update the regional carbon sequestration atlas (D81) for distribution at the 2011 PCOR Partnership Annual Meeting.

- Develop a demonstration project reporting system (DPRS). Information specific to the demonstration tests will be maintained, utilized, and reported to DOE and partners through a DPRS. The DPRS will be a Web-based interface that will house data from each demonstration activity and facilitate communication and interpretation of these data. The DPRS will be designed to provide structured access to data by all demonstration participants and other partners and to allow for efficient replication of additional or related demonstration projects (D10).

- Update the DSS (D9), including a new GIS interface that is easier and more intuitive for users.

Task 2 – Public Outreach and Education

During the next program year (October 1, 2010 – September 30, 2011), the following activities will be undertaken:

- Update the public PCOR Partnership Web site to include video segments excerpted from "Global Energy and Carbon: Tracking Our Footprint." Other sections may be developed or altered as needed.

- Develop a fact sheet (D15) profiling the Bell Creek test site.

- Update the PowerPoint presentations for Phase III general activities (D17) and the Fort Nelson demonstration (D19). In addition, develop a PowerPoint presentation for the Bell Creek demonstration (D18). Other PowerPoint presentations may be developed as needed.

- Continue to develop video products to meet the needs of general and site-level outreach.

- Develop two posters (D25 and D26) profiling the two demonstration projects.

- Identify and act on opportunities to provide outreach both at the regional level and in the vicinity of the demonstrations and address needs with respect to general information on CO_2 storage as well as information on the specific demonstration projects. Activities may include public presentations, assembly of materials for the press and for specific audiences, including middle and high school students, conducting focus groups and undertaking other means of gaining audience feedback to gauge the knowledge of target audiences as well as the effectiveness of outreach materials, and working with outreach and education professionals in an effort to improve the effectiveness of outreach and education activities.

- Continue participation in the RCSP OWG, the Weyburn–Midale Outreach Advisory Panel, and the Aquistore Project Communications Advisory Group.

Task 3 – Permitting and NEPA Compliance

During the next program year (October 1, 2010 – September 30, 2011), the following activities will be undertaken:

- Continue to gather information on current and planned CO_2 storage-related regulations at the state, province, and federal levels and continue to participate in the IOGCC Regulatory Working Group.

- Prepare DOE's environmental questionnaire (D28) for the Bell Creek test site.

- Develop a permitting action plan (D29) in conjunction with the site owner in accordance with relevant local, state, and federal regulatory requirements for the Bell Creek test site.

- Interface with relevant regulatory agencies within the PCOR Partnership region as well as with federal regulatory agencies (United States and Canada) to understand the regulatory framework for project implementation. This may include planning a third regulatory meeting.

- Prepare a permitting review for two additional states (D4) in the PCOR Partnership region.

- Continue participation in IOGCC activities, including the PTTF, as well as in the North Dakota CCS Task Force.

Task 4 – Site Characterization and Modeling

During the next program year (October 1, 2010 – September 30, 2011), the following activities will be undertaken:

- Bell Creek Test Site

  – Evaluate baseline geology toward the development of a geological characterization experimental design package (D31) that describes the specific approaches and analytical techniques used to conduct the required activities.

  – Develop a baseline hydrogeological experimental design package (D34) describing the specific approaches and techniques that will be used to conduct hydrostratigraphic delineation, aquifer and aquitard geometry and thickness, rock properties relevant to the flow of formation waters and injected CO_2, geothermal and pressure regimes, and direction and strength of formation water flow.

  – Examine the geomechanical properties of the reservoir and cap rock and stress regime in the area to assess the mechanical integrity of the system and potential for rock fracturing, and develop a geomechanical experimental design package (D87).

- Fort Nelson demonstration site

  – Assess the geomechanical properties of the reservoir and cap rock and stress regime in the area for the mechanical integrity of the system and potential for rock fracturing. Activities may include, but are not necessarily limited to, in situ stress orientation and magnitude analysis, log-based analysis of rock mechanical properties, laboratory tests on geomechanical properties of key rocks, and geomechanical modeling. The results of these activities will ultimately be presented in a geomechanical final report for the Fort Nelson site (D40).

– Conduct laboratory tests on samples of the target injection formation and key sealing formations under reservoir conditions to assess the geochemical reactions anticipated to occur between the injected gas and the rocks and fluids of the reservoir and seal. Mineral compositions will be obtained using x-ray diffraction, x-ray fluorescence, and scanning electron microscopy techniques. Samples of fluids from key formations in the selected oil field will be collected and analyzed for major and minor constituents. Laboratory results will be used to refine geochemical models which will be integrated with CO_2 fate predictive modeling efforts. The results of these activities will ultimately be presented in a geochemical final report for the Fort Nelson site (D41).

Task 5 – Well Drilling and Completion

During the next program year (October 1, 2010 – September 30, 2011), the following activities will be undertaken:

- Work with the operator of the Bell Creek oil field to develop engineering designs for the installation of necessary injection, production, and monitoring wells. The development of operational plans for the injection and recycling of CO_2 over the duration of the project will also be conducted.

Task 6 – Infrastructure Development

During the next program year (October 1, 2010 – September 30, 2011), the following activities will be undertaken:

- Report – "Opportunities and Challenges Associated with CO_2 Compression and Transportation During CCS Activities (D85)."

- Regional infrastructure needs will continue to be investigated. Information will be made available for possible inclusion in the DSS.

- The PCOR Partnership will assist its commercial partners with the activities required to develop the infrastructure to deliver CO_2 to the EOR site for the Bell Creek demonstration.

- Further investigate the issues associated with integration of advanced compression technology into a CO_2 storage project and lay the groundwork for potential incorporation of the Ramgen technology into the Bell Creek demonstration project.

- Finalize the carbon technology overview value-added report.

- Continue to work with the EERC's PCOC Program in order to share resources and maximize use of DOE funding.

- Investigate a phased approach to building a pipeline network for CO_2 transport during CCS.

Task 7 – CO_2 Procurement

During the next program year (October 1, 2010 – September 30, 2011), the following activities will be undertaken:

- Continue to interface with commercial partners with respect to CO_2 procurement for CCS and EOR activities in the region.

- Continue to keep abreast of the various commercial issues associated with CO_2 procurement, such as contractual pricing mechanisms for CO_2, other potential customers, etc.

Task 8 – Transportation and Injection Operations

During the next program year (October 1, 2010 – September 30, 2011), the following activities will be undertaken:

- Monitor and assess the CO_2 transport and injection operations conducted by the site owner/operator of the Bell Creek test site.

Task 9 – Operational Monitoring and Modeling

During the next program year (October 1, 2010 – September 30, 2011), the following activities will be undertaken:

- Develop a site characterization modeling and monitoring plan for the Bell Creek test (D50) based on tests used to monitor the CO_2 plume, potential for reservoir failure, injection well conditions, and leakage to overlying formations. Determine possible monitoring activities based on a technical and cost analysis and consider possible MVA techniques.

- Follow a preproposal sent in May 2010 with a proposal to DOE NETL for participation in the Sim-SEQ project, along with other modeling teams from the regional partnerships. The Sim-SEQ project intends to objectively evaluate the modeling efforts of different research groups as they are applied to the Phase III GS field tests anticipated to be undertaken over the next several years. In order to effectuate better management control of this project, plans are under way to request approval from DOE NETL to create a separate task for the Sim-SEQ work.

Task 10 – Site Closure

No activity is anticipated during the next program year.

Task 11 – Postinjection Monitoring and Modeling

No activity is anticipated during the next program year.

Task 12 – Project Assessment

During the next project year, the following activities will be undertaken:

- Prepare the Annual Project Assessment Report (D57).

Task 13 – Project Management

During the next program year (October 1, 2010 – September 30, 2011), the following activities will be undertaken:

- Continue to ensure timely production of deliverables and overall project management.
- Continue to expand the PCOR Partnership's membership base.
- Plan the next annual meeting.
- Continue to participate in and support RCSP efforts.
- Revise the project management plan as necessary.
- Prepare a programmatic risk management plan that includes identification and documentation of program and individual project risks, consequences, and impacts.

Task 14 – RCSP Water Working Group Coordination

During the next program year (October 1, 2010 – September 30, 2011), the following activities will be undertaken:

- Continue to conduct monthly WWG conference calls.
- Plan and conduct the third annual meeting of the WWG.

PROJECT RECOGNITION/TRAVEL

Project Recognition

- John Harju was appointed by U.S. Secretary of Energy Steven Chu to serve as a member of the National Petroleum Council for the 2010–2011 membership term.

- John Harju was appointed the Chairman of the Energy Resources, Research, and Technology Committee of the IOGCC.

- On October 8, 2009, the Lignite Energy Council presented Ed Steadman and John Harju with the "Distinguished Service – Research and Development Award" because of their leadership and counsel on CO_2 storage projects involving the lignite industry.

- At its October 2009 London Ministerial Meeting, the CSLF recognized the Fort Nelson CCS Project, a partnership initiative of Spectra Energy Transmission (SET), the EERC PCOR Partnership, the province of British Columbia, and the government of Canada. If proven feasible, the project would be one of the first commercial-scale CCS projects to inject over 1 million tonnes a year of CO_2 into a brine-saturated formation in North America, making it one of the largest CCS projects in the world.

- Received notification on September 22, 2010, that the Government Documents Roundtable of NDLA had nominated "Managing Carbon Dioxide: the Geologic Solution" (DVD) for its 2010 Notable Document Award; the Roundtable then distributed the PCOR Partnership Web link for the online streaming version of the documentary to all NDLA members.

Travel for BP4, Y3

EERC staff travel extensively in its operation of the PCOR Partnership. The PCOR Partnership was represented at over 55 conferences and meetings. Staff also traveled to numerous project meetings, editing sessions, and training seminars. The following trips briefly summarize the nature and extent of those travels:

- October 8, 2009: Traveled to accept an award at the LEC's Annual Meeting in Bismarck, North Dakota.
- October 8–15, 2009: Presented at the Third CSLF Ministerial meeting in London, England.
- October 12–17, 2009: Traveled to collect rock samples for the new U.S. field demonstration site.
- October 15–22, 2009: Presented at the 2009 Portland Geological Society annual meeting and attended the Geological Society of America Short Course: No. 506 Structural and Stratigraphic Concepts Applied to Basin Exploration in Portland, Oregon.
- October 25–27, 2009: Attended an Aquistore outreach and communication strategy meeting in Regina, Saskatchewan, Canada.
- October 27–30, 2009: Attended an Optimized Gas Treating Seminar in Houston, Texas.
- November 1–5, 2009: Participated in the 2009 Society of Petroleum Engineers International Conference on CO_2 Capture, Storage, and Utilization (November 2–4, 2009) in San Diego, California.
- November 4–7, 2009: Visited the Petroleum Engineering Lab to discuss core flood apparatus at Stanford University in San Francisco, California.

- November 2–4, 2009: Attended the North Dakota GIS User Conference in Grand Forks, North Dakota.
- November 4–5, 2009: Attended the PCOR Partnership project planning meeting with Brian Strasizar in Pittsburgh, Pennsylvania.
- November 6, 9, 2009: Attended meetings with Dave Nakles from Carnegie Mellon University, in Washington, D.C.
- November 8–10, 2009: Participated in the Great Plains Energy Expo and Showcase (November 9–10, 2009) in Bismarck, North Dakota.
- November 9–12, 2009: Participated in the Simulia Training Course entitled "Analysis of Geotechnical Problems with Abaqus" in Houston, Texas.
- November 15–19, 2009: Participated in the RCSP annual review meeting in Pittsburgh, Pennsylvania.
- November 30 – December 3, 2009: Participated in the PCOR Partnership annual meeting and workshops in St. Louis, Missouri.
- December 7–8, 2009: Attended the 7th Annual EOR Carbon Management Workshop in Houston, Texas.
- December 9–11, 2009: Attended the 15th Annual CO_2 Flooding Conference in Midland, Texas.
- December 15–18, 2009: Presented at the 2009 AGU Fall Meeting Union Session U02: Geophysical Monitoring, Verification, and Accounting for Geologic Carbon Sequestration in San Francisco, California.
- January 11–12, 2010: Met with representatives of Nebraska Public Power District in Lincoln, Nebraska.
- January 12–15, 2010: Presented at the Seals and Caprocks in Geologic Carbon Sequestration Workshop in Pacific Grove, California.
- January 19–20, 2010: Presented before the North Dakota Oil and Gas Research Council in Bismarck, North Dakota.
- January 20–22, 2010: Participated in the IOGCC RCSP "Lessons Learned" exercise in Santa Fe, New Mexico.
- January 25–27, 2010: Participated in the Groundwater Protection Council 2010 UIC Conference held in Austin, Texas.
- January 26–28, 2010: Met with representatives of Spectra Energy in Calgary, Alberta, Canada.
- January 31 – February 3, 2010: Traveled for a presentation on February 1, 2010, at the 2010 EUEC Energy and Environment Conference in Phoenix, Arizona.
- February 15–18, 2010: Attended the IEA Greenhouse Gas R&D Programme's CO_2 Geological Storage Modelling Meeting on February 16–17, 2010, in Salt Lake City, Utah.
- February 16–18, 2010: Presented as an invited speaker at the Texas Carbon Capture and Storage Association CO_2 Storage Policy seminar and attended the 2010 Carbon and Climate Change Conference in Austin, Texas.
- February 21–24, 2010: Attended project meetings with Spectra Energy, Weatherford Laboratories, and RPS Energy Canada in Calgary, Alberta, Canada.
- February 22–27, 2010: Attended CMG's courses CMOST and CO_2 Sequestration with GEM February 23–26, 2010, in Houston, Texas.

- February 25, 2010: Attended a meeting with Denbury Resources in Bismarck, North Dakota.
- March 4, 16, 18, 22, 24, 30, and 31, 2010: Participated in editing sessions at Prairie Public Broadcasting in Fargo, North Dakota.
- March 7–13, 2010: Attended meetings with Alberta Innovates – Technology Futures and participated in CMG training courses entitled "Geochemistry for GEM" and "CO_2 Sequestration with GEM" in Calgary, British Columbia, Canada.
- March 8–11, 2010: Participated in the third NACAP Working Group Meeting held March 9–10, in Cuernavaca, Mexico.
- March 22–24, 2010: Presented a PCOR Partnership overview before the Assistant Secretary for Fossil Energy and associated staff on March 23 in Washington, D.C.
- March 27 – April 4, 2010: Attended the 6th Institute of Mathematics and its Applications Conference on Modelling Permeable Rocks, held March 29 – April 1 in Edinburgh, Scotland.
- April 9–15, 2010: Attended two short courses entitled "Assessment of Unconventional Shale Resources Using Geochemistry" and "Reservoir Engineering for Geologists" in New Orleans, Louisiana.
- April 11–12, 2010: Presented at the Joint Section Meeting of the Geological Society of America North-Central and South-Central Sections in Branson, Missouri.
- April 11–14, 2010: Attended and presented at the AAPG 2010 Annual Convention & Exhibition in New Orleans, Louisiana.
- April 16 and 21, 2010: Participated in documentary editing sessions at PPB in Fargo, North Dakota.
- April 18–19, 2010: Attended the CO_2 Capture and Storage Information Needs and Knowledge Sharing Workshop for Alberta's Four Large-Scale Demonstration Projects in Calgary, Alberta, Canada.
- April 24–30, 2010: Attended the IEA Greenhouse Gas R&D Programme 6th Wellbore Integrity Network Meeting in The Hague, Amsterdam.
- April 24–30, 2010: Attended the 17th Society of Petroleum Engineers Improved Oil Recovery Symposium and short courses in Tulsa, Oklahoma.
- April 26–30, 2010: Attended the AAPG short course entitled "Basic Well Log Analysis" in Austin, Texas.
- May 1–4, 2010: Attended and exhibited at 18th Williston Basin Petroleum Conference & Expo, Bismarck, North Dakota, May 2–4, 2010.
- May 4, 2010: Participated in PCOR Partnership educational materials development meeting with PPB, Fargo, North Dakota.
- May 5–6, 2010: Attended EPA and DOE'S First Public Meeting of Interagency Task Force on Carbon Capture and Storage, Washington, D.C., May 6, 2010.
- May 5–7, 2010: Presented at IEA Greenhouse Gas R&D Programme's 6th Monitoring Network Meeting, Natchez, Mississippi, May 6–8, 2010.
- May 9–13, 2010: Presented at 9th Annual Conference on Carbon Capture and Sequestration, Pittsburgh, Pennsylvania, May 10–13, 2010.
- May 10, 2010: Attended 2010 U.S.–Canada Clean Energy Dialogue Bilateral National Conference, Pittsburgh, Pennsylvania.

- May 20–26, 2010: Participated in IOGCC Pipeline Transportation Task Force meeting, Lexington, Kentucky, May 20–21, 2010, and attended IOGCC 2010 Midyear Issues Summit, Lexington, Kentucky, May 23–25, 2010.
- May 25–27, 2010: Participated in meeting with DGLS regarding characterization of Forest City Basin, Rolla, Missouri, May 26, 2010.
- June 1–4, 2010: Participated in meetings with Spectra Energy in Calgary, Alberta, Canada.
- June 1–4, 2010: Presented at the Canadian Institute's 13th Annual BC Natural Gas Symposium in Vancouver, British Columbia, Canada.
- June 6–7, 2010: Presented at the Geologic Carbon Sequestration Site Integrity: Characterization and Monitoring Science and Technology Workshop in Columbus, Ohio.
- June 7–11, 2010: Attended the AAPG Hedberg Research Conference entitled Applications of Reservoir Fluid Geochemistry in Vail, Colorado.
- June 8–10, 2010: Presented at the NDPC's 2010 Teacher Education Seminar in Bismarck, North Dakota.
- June 13–15, 2010: Presented at the AAPG Rocky Mountain Section Meeting in Durango, Colorado.
- June 14–16, 2010: Presented at LEC's 2010 Lignite Education Seminar: Energy, Economics and Environment in Bismarck, North Dakota.
- June 15–18, 2010: Participated in project meetings with subcontractors in Calgary and Edmonton, Alberta, Canada.
- June 19–21, 2010: Attended advanced D8 x-ray diffractometer service training (and received certification) at Bruker AXS Inc. in Madison, Wisconsin.
- June 21–24, 2010: Attended an IEA Greenhouse Gas R&D Programme Weyburn–Midale CO_2 Monitoring and Storage Project (PRISM–VI) meeting in Saskatoon, Saskatchewan, Canada.
- June 22–24, 2010: Participated in an RCSP OWG meeting in Washington, D.C.
- June 24–25, 2010: Presented at a DOE Fossil Energy–Masdar Cooperation Workshop in Pittsburgh, Pennsylvania.
- June 28 – July 1, 2010: Attended the 4th Annual Wyoming CO_2 Conference in Casper, Wyoming.
- June 28 – July 5, 2010: Traveled to Bueyeros, New Mexico, with PPB personnel to capture images of the Bravo Dome CO_2 production, regional setting, and geology.
- July 6–10, 2010: Attended and presented at CMG's Technical Symposium 2010 in Calgary, Alberta, Canada.
- July 11–16, 2010: Attended the Esri International User Conference held in San Diego, California.
- July 11–25, 2010: Attended Schlumberger Petrel seismic interpretation software training courses in Houston, Texas.
- July 13–15, 2010: Attended 4th Annual Carbon Capture & Sequestration: The Business Summit in Washington, D.C.
- July 18–28, 2010: Attended Schlumberger Techlog and Petrel software training courses in Houston, Texas.
- July 19–20, 2010: Traveled to the Bell Creek oil field in southeastern Montana.

- July 20–22, 2010: Hosted the second annual PCOR Partnership regulatory meeting in Deadwood, South Dakota.
- June 28 – July 5, 2010: Traveled with PPB to Pueblo, Colorado, to gather imagery for use in outreach materials and presentations.
- August 4, 2010: Traveled for an edit session at PPB's offices in Fargo, North Dakota.
- August 5–6, 2010: Attended the Midwest Geological Sequestration Consortium STEP Advisory Group meeting in Champaign, Illinois.
- August 8–19, 2010: Attended Schlumberger software training courses, i.e., Petrel Introduction and Petrel Reservoir Engineering, in Houston, Texas.
- August 9–13, 2010: Presented at the AAPG Geosciences Technology Workshop on Carbon Capture and Sequestration in Golden, Colorado.
- August 19–20, 2010: Attended partner meetings in Bismarck, North Dakota.
- August 24, 2010: Traveled for an editing session at PPB's offices in Fargo, North Dakota.
- August 29 – September 1, 2010: Traveled to Calgary, Alberta, Canada, for meetings with Spectra Energy and traveled to Edmonton, Alberta, Canada, for meetings with Natural Resources Canada.
- September 1, 17, and 21, 2010: Traveled for editing sessions to PPB's offices in Fargo, North Dakota.
- September 9–10, 2010: Attended Computer Modelling Group Training entitled "Chemical and Thermal EOR Modelling with STARS" in Houston, Texas.
- September 13–17, 2010: Attended Schlumberger training courses entitled Techlog Basic and Techlog Fundamentals in Houston, Texas.
- September 13–17, 2010: Attended the DOE/NETL 2010 CO_2 Capture Technology Meeting in Pittsburgh, Pennsylvania.
- September 19–23, 2010: Participated in GHGT-10 in Amsterdam, the Netherlands.
- September 22–23, 2010: Attended the NDPC Annual Meeting in Minot, North Dakota.
- September 28–30, 2010: Attended the Second International Acid Gas Injection Symposium and Acid Gas Injection Workshop in Calgary, Alberta, Canada.
- September 28, 2010: Presented at the Water–Energy Sustainability Symposium 2010 in Pittsburgh, Pennsylvania.
- September 29–30, 2010: Presented at the American Conference Institute's 4th Annual Carbon Capture and Sequestration Summit in Washington, D.C.

Materials presented at these meetings are available to partners on the PCOR Partnership DSS Web site (www2.undeerc.org/website/pcorp/ProductsDB/Default.aspx).

REFERENCE

1. www.netl.doe.gov/technologies/carbon_seq/overview/program_goals.html (accessed December 2010).

PHASE III PRODUCTS/PUBLICATIONS

During PY3, the PCOR Partnership submitted 45 abstracts, all but one of which were accepted with four currently remaining in review. The PCOR Partnership submitted 20 papers and gave nearly 80 presentations (oral and poster combined). In addition, it completed 12 deliverable reports, prepared conference call and meeting minutes, and prepared five value-added products.

Abstracts – Accepted for Presentation

Ayash, S.C., Giry, E.F., Frenette, R., Meyer, V., Moffatt, D.J., Sorensen, J.A., Steadman, E.N., and Harju, J.A., 2009, A new risk management methodology for large-scale CO_2 storage—application to the Fort Nelson carbon capture and storage project [abs.]: International Conference on Greenhouse Gas Control Technologies (GHGT-10), Amsterdam, The Netherlands, September 19–23, 2010.

Ayash, S.C., Giry, E., Frenette, R., Meyer, V., Moffatt, D., Sorensen, J.A., Steadman, E.N., and Harju, J.A., 2010, A new risk management methodology for large-scale CO_2 storage—application to Spectra Energy's proposed Fort Nelson carbon capture and storage project [abs.]: 9th Annual Conference on Carbon Capture & Sequestration, Pittsburgh, Pennsylvania, May 10–13, 2010.

Braunberger, J.R., Bremer, J.M., Liu, G., Gorecki, C.D., Sorensen, J.A., Steadman, E.N., and Harju, J.A., 2010, Characterization and modeling using macrofacies and microfacies intervals of the rival "Nesson" beds in the Mississippian Lower Charles Formation, Burke County, North Dakota [abs.]: American Association of Petroleum Geologists (AAPG) 2011 Annual Convention & Exhibition, Houston, Texas, April 10–13, 2011 [in review].

Burke, L., Smith, S.A., Sorensen, J.A., Steadman, E.N., Harju, J.A., Ryan, D., Nimchuk, D., and Jackson, B., 2009, Evaluation of structural integrity at the Zama acid gas EOR, CO_2 storage, and monitoring project [abs.]: International Conference on Greenhouse Gas Control Technologies (GHGT-10), Amsterdam, The Netherlands, September 19–23, 2010.

Daly, D.J., Bradbury, J., Garrett, G., Greenberg, S., Myhre, R., Peterson, T., Tollefson, L., and Wade, S., 2009, Road-testing the outreach best practices manual—applicability for implementation of the development phase projects by the Regional Carbon Sequestration Partnerships [abs.]: International Conference on Greenhouse Gas Control Technologies (GHGT-10), Amsterdam, The Netherlands, September 19–23, 2010.

Daly, D.D., Crocker, C.R., Hanson, S.K., Steadman, E.N., and Harju, J.A., 2010, Covering the bases—regional- and project-level outreach for sequestration [abs.]: 9th Annual Conference on Carbon Capture & Sequestration, Pittsburgh, Pennsylvania, May 10–13, 2010.

Daly, D.D., and Sacuta, N., 2010, Cross-border collaboration in applying outreach best practices to Aquistore project [abs]: 9th Annual Conference on Carbon Capture & Sequestration, Pittsburgh, Pennsylvania, May 10–13, 2010.

Gorecki, C.D., and Wildgust, N., 2009, An overview of the IEA Greenhouse Gas R&D Programme regional geologic storage capacity studies [abs.]: International Conference on Greenhouse Gas Control Technologies (GHGT-10), Amsterdam, The Netherlands, September 19–23, 2010.

Gorecki, C.D., Klapperich, R.J., Bremer, J.M., Holubnyak, Y.I., and McNemar, A., 2010, Regional carbon sequestration partnership—water working group [abs.]: 9th Annual Conference on Carbon Capture & Sequestration, Pittsburgh, Pennsylvania, May 10–13, 2010.

Gorecki, C.D., Sorensen, J.A., Knudsen, D.J., Bremer, J.M., Steadman, E.N., Harju, J.A., and Wildgust, N., 2010, Developing resource estimates for CO_2 storage in regional deep saline formations [abs.]: 9th Annual Conference on Carbon Capture & Sequestration, Pittsburgh, Pennsylvania, May 10–13, 2010.

Gorecki, C.D., Liu, G., Bremer, J.M., Sorensen, J.A., Steadman, E.N., and Harju, J.A., 2010, Modeling and monitoring the Northwest McGregor huff 'n' puff EOR project [abs.]: 73rd European Association of Geoscientists & Engineers (EAGE) Conference & Exhibition incorporating SPE EUROPEC 2011, Vienna, Austria, May 23–26, 2011 [in review].

Gorecki, C.D., Liu, G., Bremer, J.M., Sorensen, J.A., Steadman, E.N., and Harju, J.A., 2010, Modeling and monitoring the Northwest McGregor CO_2 huff 'n' puff EOR project [abs.]: Society of Petroleum Engineers Reservoir Simulation Symposium, The Woodlands, Texas, February 21–23, 2011 [in review].

Hawthorne, S.B., Miller, D.J., Holubnyak, Y.I., Kutchko, B.G., and Strazisar, B.R., 2009, Experimental investigations of the effects of acid gas (H_2S/CO_2) exposure under geological sequestration conditions [abs.]: International Conference on Greenhouse Gas Control Technologies (GHGT-10), Amsterdam, The Netherlands, September 19–23, 2010.

Holubnyak, Y.I., Hawthorne, S.B., Mibeck, B.A.F., Miller, D.J., Bremer, J.M., Sorensen, J.A., Steadman, E.N., and Harju, J.A., 2009, Modeling CO_2–H_2S–water–rock interactions in Williston Basin carbonates under reservoir conditions [abs.]: International Conference on Greenhouse Gas Control Technologies (GHGT-10), Amsterdam, The Netherlands, September 19–23, 2010.

Holubnyak, Y.I., Knudsen, D.J., Mibeck, B.A., Bremer, J.M., Smith, S.A., Sorensen, J.A., Gorecki, C.D., Steadman, E.N., and Harju, J.A., 2009, Geochemical modeling of carbon dioxide injections into carbonate formation in the northwest McGregor oil field for CO_2 storage and enhanced oil recovery (EOR) [abs]: American Association of Petroleum Geologists (AAPG) Annual Convention and Exhibition, New Orleans, Louisiana, April 11–14, 2010.

Holubnyak, Y.I., Knudsen, D.J., Mibeck, B.A., Bremer, J.M., Smith, S.A., Sorensen, J.A., Gorecki, C.D., Steadman, E.N., and Harju, J.A., 2009, Investigation of geochemical interactions of carbon dioxide and carbonate formation in the northwest McGregor oil field after enhanced oil recovery and CO_2 storage [abs.]: International Conference on Greenhouse

Gas Control Technologies (GHGT-10), Amsterdam, The Netherlands, September 19–23, 2010.

Holubnyak, Y.I., Hawthorne, S.B., Mibeck, B.A., Miller, D.J., Bremer, J.M., Smith, S.A., Sorensen, J.A., Steadman, E.N., and Harju, J.A., 2010, Laboratory and numerical modeling of CO_2–H_2S–water–rock interactions at Williston Basin reservoir conditions [abs.]: 9th Annual Conference on Carbon Capture & Sequestration, Pittsburgh, Pennsylvania, May 10–13, 2010.

Holubnyak, Y.I., Knudsen, D.J., Mibeck, B.A., Bremer, J.M., Smith, S.A., Sorensen, J.A., Gorecki, C.D., Steadman, E.N., and Harju, J.A., 2010, Geochemical modeling of enhanced oil recovery and CO_2 storage at the Northwest McGregor oil field [abs.]: 9th Annual Conference on Carbon Capture & Sequestration, Pittsburgh, Pennsylvania, May 10–13, 2010.

Holubnyak, Y.I., Smith, S.A., Sorensen, J.A., Steadman, E.N., and Harju, J.A., 2010, Introducing new statistical methods in geochemical kinetics modeling for better estimations of CO_2–water–rock interactions [abs.]: 9th Annual Conference on Carbon Capture & Sequestration, Pittsburgh, Pennsylvania, May 10–13, 2010.

Holubnyak, Y.I., Hawthorne, S.B., Mibeck, B.A., Miller, D.J., Bremer, J.M., Smith, S.A., Sorensen, J.A., Steadman, E.N., and Harju, J.A., 2010, Comparison of CO_2 and acid gas interactions with reservoir fluid and rocks at Williston Basin conditions [abs.]: 2nd International Acid Gas Injection Symposium, Calgary, Alberta, September 28–29, 2010.

Holubnyak, Y.I., Mibeck, B.A., Bremer, J.M., Smith, S.A., Sorensen, J.A., Gorecki, C.D., Steadman, E.N., and Harju, J.A., 2010, Geochemical modeling of huff 'n' puff oil recovery with CO_2 at the Northwest McGregor oil field [abs.]: 2nd International Acid Gas Injection Symposium, Calgary, Alberta, September 28–29, 2010.

Holubnyak, Y.I., Hawthorne, S.B., Mibeck, B.A., Miller, D.J., Bremer, J.M., Smith, S.A., Sorensen, J.A., Steadman, E.N., and Harju, J.A., 2010, Geochemical interactions of CO_2 with reservoir fluid and rocks of Powder River Basin [abs.]: 2010 Geological Society of America Annual Meeting, Denver, Colorado, October 31 – November 3, 2010.

Holubnyak, Y.I., Mibeck, B.A., Bremer, J.M., Smith, S.A., Sorensen, J.A., Gorecki, C.D., Steadman, E.N., and Harju, J.A., 2010, Geochemical modeling of EOR with CO_2 at the Northwest McGregor oil field [abs.]: 2010 Geological Society of America Annual Meeting, Denver, Colorado, October 31 – November 3, 2010.

Holubnyak, Y.I., Rygalov, V., Smith, S.A., Sorensen, J.A., Steadman, E.N., and Harju, J.A., 2010, Statistical probability estimations for geochemical kinetics modeling of CO_2–water–rock interactions [abs.]: 2010 Geological Society of America Annual Meeting, Denver, Colorado, October 31 – November 3, 2010.

Holubnyak, Y.I., Liu, G., Mibeck, B.A., Bremer, J.M., Smith, S.A., Sorensen, J.A., Gorecki, C.D., Steadman, E.N., and Harju, J.A., 2010, Geochemical modeling of CO_2-based huff 'n'

puff oil recovery at the Northwest McGregor oil field: Submitted to the 2011 SPE International Symposium on Oilfield Chemistry, The Woodlands, Texas, April 11–13, 2011 [in review].

Jensen, M.D., Pavlish, B.M., Pei, P., Leroux, K.M.B., Steadman, E.N., and Harju, J.A., 2010, Estimating the cost to capture, compress, and transport CO_2 from stationary sources in the PCOR Partnership region [abs.]: 9th Annual Conference on Carbon Capture & Sequestration, Pittsburgh, Pennsylvania, May 10–13, 2010.

Klapperich, R.J., Gorecki, C.D., and McNemar, A., 2010, Regional carbon sequestration partnerships water working group [abs.]: 2010 Ground Water Protection Council (GWPC) Water/Energy Sustainability Symposium, Pittsburgh, Pennsylvania, September 26–29, 2010.

Knudsen, D.J., Gorecki, C.D., Bremer, J.M., Holubnyak, Y.I., Mibeck, B.A., Schmidt, D.D., Smith, S.A., Sorensen, J.A., Steadman, E.N., and Harju, J.A., 2009, Characterization and modeling of a CO_2 huff 'n' puff to predict and verify EOR production and CO_2 storage [abs]: American Association of Petroleum Geologists (AAPG) Annual Convention and Exhibition, New Orleans, Louisiana, April 11–14, 2010.

Knudsen, D.J., Liu, G., Gorecki, C.D., Sorensen, J.A., Steadman, E.N., and Harju, J.A., 2010, History matching a CO_2 huff 'n' puff EOR project with CMG's GEM and CMOST [abs.]: 9th Annual Conference on Carbon Capture & Sequestration, Pittsburgh, Pennsylvania, May 10–13, 2010.

Knudsen, D.J., Gorecki, C.D., Smith, S.A., Sorensen, J.A., Steadman, E.N., and Harju, J.A., 2009, Modeling and simulation workflow for a fractured carbonate CO_2 huff 'n' puff—a case study in the Williston Basin, North Dakota, USA [abs.]: 6th Institute of Mathematics and Its Applications Conference on Modeling Permeable Rocks, Edinburgh, Scotland, United Kingdom, March 29 – April 1, 2010.

Moffatt, D., Laundry, A., Sorensen, J.A., Smith, S.A., Steadman, E.N., and Harju, J.A., 2009, The Fort Nelson carbon capture and storage project—a program for large-scale geologic storage of CO_2 from a natural gas-processing plant in British Columbia, Canada [abs.]: International Conference on Greenhouse Gas Control Technologies (GHGT-10), Amsterdam, The Netherlands, September 19–23, 2010.

Schmidt, D.D., Steadman, E.N., and Harju, J.A., 2010, CO_2 storage pilot study for lignite coal [abs.]: 9th Annual Conference on Carbon Capture & Sequestration, Pittsburgh, Pennsylvania, May 10–13, 2010.

Smith, S.A., 2009, Overview of the Zama acid gas EOR, CO_2 sequestration, and monitoring project [abs]: American Association of Petroleum Geologists (AAPG) Annual Convention and Exhibition, New Orleans, Louisiana, April 11–14, 2010.

Smith, S.A., Sorensen, J.A., Steadman, E.N., and Harju, J.A., 2010, Zama acid gas EOR, CO_2 sequestration, and monitoring project [abs.]: 9th Annual Conference on Carbon Capture & Sequestration, Pittsburgh, Pennsylvania, May 10–13, 2010.

Sorensen, J.A., Knudsen, D.J., Smith, S.A., Gorecki, C.D., Steadman, E.N., and Harju, J.A., 2009, Northwest McGregor Field CO_2 huff 'n' puff—a case study of the application of field monitoring and modeling techniques for CO_2 prediction and accounting [abs.]: International Conference on Greenhouse Gas Control Technologies (GHGT-10), Amsterdam, The Netherlands, September 19–23, 2010.

Sorensen, J.A., Knudsen, D.J., Pluemer, B., Smith, S.A., Gorecki, C.D., Steadman, E.N., and Harju, J.A., 2010, Northwest McGregor field CO_2 huff 'n' puff—a case study of the application of selected geophysical techniques for CO_2 monitoring in a deep carbonate reservoir [abs.]: 9th Annual Conference on Carbon Capture & Sequestration, Pittsburgh, Pennsylvania, May 10–13, 2010.

Sorensen, J.A., Schmidt, D.D., Knudsen, D.J., Smith, S.A., Gorecki, C.D., Steadman, E.N., and Harju, J.A., 2010, Results of the Plains CO_2 Reduction Partnership's Phase II demonstration in the Northwest McGregor oil field, North Dakota [abs.]: 9th Annual Conference on Carbon Capture & Sequestration, Pittsburgh, Pennsylvania, May 10–13, 2010.

Steadman, E.N., Harju, J.A., Daly, D.J., Gorecki, C.D., Jensen, M.D., Peck, W.D., Smith, S.A., and Sorensen, J.A., 2009, The Plains CO_2 Reduction (PCOR) Partnership—developing carbon management options for the central interior of North America [abs.]: International Conference on Greenhouse Gas Control Technologies (GHGT-10), Amsterdam, The Netherlands, September 19–23, 2010.

Steadman, E.N., Harju, J.A., Anagnost, K.K., Daly, D.J., Gorecki, C.D., Jensen, M.D., Peck, W.D., Smith, S.A., and Sorensen, J.A., 2010, The Plains CO_2 Reduction (PCOR) Partnership—carbon capture and storage demonstration activities [abs.]: 9th Annual Conference on Carbon Capture & Sequestration, Pittsburgh, Pennsylvania, May 10–13, 2010.

Steadman, E.N., Harju, J.A., Daly, D.J., Gorecki, C.D., Jensen, M.D., Peck, W.D., Smith, S.A., and Sorensen, J.A., 2010, The Plains CO_2 Reduction (PCOR) Partnership—carbon capture and storage demonstration activities [abs]: American Association of Petroleum Geologists – Rocky Mountain Section Meeting, Durango, Colorado, June 13–16, 2010.

Steadman, E.N., Harju, J.A., Daly, D.J., Gorecki, C.D., Jensen, M.D., Peck, W.D., Smith, S.A., and Sorensen, J.A., 2010, The Plains CO_2 Reduction (PCOR) Partnership—developing carbon management options for the central interior of North America [abs.]: Geological Society of America North-Central Section (44th Annual) and South-Central Section (44th Annual) Joint Meeting, Branson, Missouri, April 11–13, 2010.

Steadman, E.N., Harju, J.A., Sorensen, J.A., Smith, S.A., Ayash, S.C., Gorecki, C.D., Daly, D.J., Jensen, M.D., and Peck, W.D., 2010, The Plains CO_2 Reduction (PCOR) Partnership—collaborative U.S.–Canada carbon capture and storage demonstration activities [abs.]: 9th

Annual Conference on Carbon Capture & Sequestration, Pittsburgh, Pennsylvania, May 10–13, 2010.

Steadman, E.N., Harju, J.A., Anagnost, K.K., Botnen, L.S., Daly, D.J., Gorecki, C.D., Jensen, M.D., Peck, W.D., Smith, S.A., and Sorensen, J.A., 2010, The Plains CO_2 Reduction (PCOR) Partnership—ongoing carbon management activities in the interior plains of North America [abs.]: EUEC 2011 Energy & Environment Conference, Phoenix, Arizona, January 31 – February 2, 2011.

Abstracts – Accepted but Author(s) Declined Invitation

Botnen, B.W., Steadman, E.N., and Harju, J.A., 2010, Terrestrial carbon sequestration in the northern Great Plains [abs.]: 9th Annual Conference on Carbon Capture & Sequestration, Pittsburgh, Pennsylvania, May 10–13, 2010.

Abstracts – Submitted but Not Accepted for Presentation

Daly, D.J., Hanson, S.K., Peck, W.D., Steadman, E.N., and Harju, J.A., 2010, Outreach planning and tracking [abs.]: 9th Annual Conference on Carbon Capture & Sequestration, Pittsburgh, Pennsylvania, May 10–13, 2010.

Presentations, Posters, and Other Media

Ayash, S.C., Giry, E., Frenette, R., Meyer, V., Moffatt, D., Sorensen, J.A., Steadman, E.N., Harju, J.A., and Smith, S.A., 2010, A new risk management methodology for large-scale CO_2 storage—application to Spectra Energy's Fort Nelson carbon capture and storage (CCS) feasibility project: Presented at the 9th Annual Carbon Capture & Sequestration Conference, Pittsburgh, Pennsylvania, May 10–13, 2010.

Bachu, S., Deel, D., Frailey, S., Steadman, E.N., Gorecki, C.D., and Peck, W.E., 2010, Discussion of outstanding technical issues: Presented at the 3rd North American Carbon Atlas Partnership (NACAP) Working Group Meeting, Cuernavaca, Mexico, March 9–10, 2010.

Baldwin, P., and Jensen, M.D., 2010, Ramgen project: Presented at the Plains CO_2 Reduction (PCOR) Partnership 2009 Annual Meeting, St. Louis, Missouri, December 1–3, 2009.

Botnen, B.W., Steadman, E.N., and Harju, J.A., 2009, Terrestrial carbon sequestration in the northern Great Plains: Presented at the Regional Carbon Sequestration Partnership (RCSP) Annual Review Meeting, Pittsburgh, Pennsylvania, November 16–19, 2009.

Botnen, L.S., 2010, Carbon capture and storage review and recap of 2009 PCOR Partnership regulatory meeting: Presented at the Plains CO_2 Reduction (PCOR) Partnership 2nd Annual Regulatory Meeting: Deadwood, South Dakota, July 21–22, 2010.

Botnen, L.S., Ayash, S.C., Giry, E.F., Frenette, R., Meyer, V., Moffatt, D.J., Sorensen, J.A., Steadman, E.N., and Harju, J.A., 2010, Spectra Energy's Fort Nelson CCS feasibility project: Poster presented at the International Conference on Greenhouse Gas Control Technologies (GHGT-10), Amsterdam, The Netherlands, September 19–23, 2010.

Burke, L.H., Smith, S.A., Sorensen, J.A., Steadman, E.N., Harju, J.A., Ryan, D., Nimchuk, D., and Jackson, B., 2010, Impact of acid gas exposure on cap rock integrity properties at Apache Zama EOR & storage project: Poster presented at the International Conference on Greenhouse Gas Control Technologies (GHGT-10), Amsterdam, The Netherlands, September 19–23, 2010.

Daly, D.J., 2009, Six projects, two countries, and 10 million households – outreach in the PCOR Partnership region: Presented at the Plains CO_2 Reduction (PCOR) Partnership 2009 Annual Meeting, St. Louis, Missouri, December 1–3, 2009.

Daly, D.J., 2010, Best practices—CCS–GS outreach: Presented at the 9th Annual Carbon Capture & Sequestration Conference, Pittsburgh, Pennsylvania, May 10–13, 2010.

Daly, D.J., and Crocker, C.R., 2010, Energy and CO_2 management—carbon capture and storage: Presented at the 2010 Lignite Education Seminar, Bismarck, North Dakota, June 15, 2010.

Daly, D.J., and Crocker, C.R., 2010, Energy and CO_2 management—carbon capture and storage: Presented at the North Dakota Petroleum Council Teacher Education Workshop, Bismarck, North Dakota, June 9, 2010.

Daly, D.J., Crocker, C.R., Hanson, S.K., Steadman, E.N., and Harju, J.A., 2010, Covering the bases—regional- and project-level outreach for sequestration: Presented at the 9th Annual Carbon Capture & Sequestration Conference, Pittsburgh, Pennsylvania, May 10–13, 2010.

Daly, D.J., Bradbury, J., Garrett, G., Greenberg, S., Myhre, R., Peterson, T., Tollefson, L., and Wade, S., 2010, Road-testing the outreach best practices manual—applicability for implementation of the development phase projects by the Regional Carbon Sequestration Partnerships: Poster presented at the International Conference on Greenhouse Gas Control Technologies (GHGT-10), Amsterdam, The Netherlands, September 19–23, 2010.

Gorecki, C.G., 2010, Plains CO_2 Reduction (PCOR) Partnership update: Presented at the Groundwater Protection Council (GWPC) Annual UIC Conference, Austin, Texas, January 25–27, 2010.

Gorecki, C.D., and Klapperich, R.J., 2010, Regional Carbon Sequestration Partnership Water Working Group: Presented at the 9th Annual Conference on Carbon Capture & Sequestration Regional Carbon Sequestration Partnership Water Working Group Annual Meeting, Pittsburgh, Pennsylvania, May 13, 2010.

Gorecki, C.D., Klapperich, R.J., Bremer, J.M., Holubnyak, Y., and McNemar, A., 2010, Regional Carbon Sequestration Partnership Water Working Group: Presented at the 9th

Annual Carbon Capture & Sequestration Conference, Pittsburgh, Pennsylvania, May 10–13, 2010.

Gorecki, C.D., Knudsen, D.J., Liu, G., Bremer, J.M., Sorensen, J.A., Steadman, E.N., and Harju, J.A., 2010, History matching a CO_2 huff 'n' puff EOR project with CMG's GEM and CMOST. Poster presented at the 9th Annual Carbon Capture & Sequestration Conference, Pittsburgh, Pennsylvania, May 10–13, 2010.

Gorecki, C.D., Sorensen, J.A., Bremer, J.M., Steadman, E.N., Harju, J.A., and Wildgust, N., 2010, Developing resource estimates for CO_2 storage in regional deep saline formations: Presented at the 9th Annual Carbon Capture & Sequestration Conference, Pittsburgh, Pennsylvania, May 10–13, 2010.

Gorecki, C.D., Sorensen, J.A., Bremer, J.M., Steadman, E.N., and Harju, J.A., 2010, Developing resource estimates for CO_2 storage in regional deep saline formations: Presented at the UK–US Carbon Capture & Sequestration R&D Workshop, Pittsburgh, Pennsylvania, May 10, 2010.

Gorecki, C.D., Liu, G., Sorensen, J.A., Schmidt, D.D., and Smith, S.A., 2010, History-matching a CO_2 huff 'n' puff EOR project with CMG's GEM and CMOST: Presented at CMG's Technical Symposium, Calgary, Alberta, July 7–9, 2010.

Gorecki, C.D., Liu, G., Sorensen, J.A., Schmidt, D.D., and Smith, S.A., 2010, Monitoring and modeling a CO_2 huff 'n' puff EOR test: Presented at the AAPG Geosciences Technology Workshop on Carbon Capture and Sequestration, Golden, Colorado, August 10–12, 2010.

Harju, J.A., 2009, EOR and responsible carbon management: Presented at the Plains CO_2 Reduction (PCOR) Partnership Annual Meeting, St. Louis, Missouri, December 1–3, 2009.

Harju, J.A., 2009, Introduction to CO_2 sequestration and the Plains CO_2 Reduction (PCOR) Partnership: Presented at the Great Plains Energy Expo, Bismarck, North Dakota, November 10, 2009.

Harju, J.A. (panelist), 2009, Roundtable—geologic sequestration partnerships: 7th Annual EOR Carbon Management Workshop, Houston, Texas, December 7–8, 2009.

Harju, J.A., 2010, What is North Dakota's Energy Future?: Presented at the Energy Impact Symposium—Energy Independence and Security, Minot, North Dakota, March 14–16, 2010.

Harju, J.A., Steadman, E.N., and Anagnost, K.K., 2010, Dividing responsibility into partnerships across the country—The Plains CO_2 Reduction (PCOR) Partnership—one of the U.S. Department of Energy's regional carbon sequestration partnerships: Presented at Carbon Capture and Storage World Australia 2010, Melbourne, Australia, June 21–23, 2010.

Harju, J.A., 2010, Identifying U.S. geologic basins appropriate for large-scale sequestration of CO_2 and avoiding potential pitfalls in carbon geostorage: Presented at the 4th Annual Carbon Capture and Sequestration Summit, Washington, D.C., September 29–30, 2010.

Hawthorne, S.B., Miller, D.J., Kutchko, B.G.; and Strazisar, B.R., 2009, Experimental investigations of the effects of acid gas (H_2S/CO_2) exposure under geological sequestration conditions: Presented at the 2009 American Geophysical Union (AGU) Fall Meeting, San Francisco, California, December 14–18, 2009, Poster U41-0011.

Hawthorne, S.B., Miller, D.J., Holubnyak, Y.I., Harju, J.A., Kutchko, B.G., and Strazisar, B.R., 2010, Experimental investigations of the effects of acid gas (H_2S/CO_2) exposure under geological sequestration conditions: Paper for the International Conference on Greenhouse Gas Control Technologies (GHGT-10), Amsterdam, The Netherlands, September 19–23, 2010.

Holubnyak, Y.I., Hawthorne, S.B., Mibeck, B.A.F., Miller, D.J., Bremer, J.M., Smith, S.A., Sorensen, J.A., Steadman, E.N., and Harju, J.A., 2009, Modeling geochemical reactions in a typical Williston Basin reservoir used for CO_2 and sour gas storage: Abstracts of Programs, Geological Society of America, v. 41, no. 7, p. 323.

Holubnyak, Y.I., Hawthorne, S.B., Mibeck, B.A., Miller, D.J., Bremer, J.M., Smith, S.A., Sorensen, J.A., Steadman, E.N., and Harju, J.A., 2010, Laboratory and numerical modeling of CO_2–H_2S–water–rock interactions at Williston Basin reservoir conditions: Presented at the 9th Annual Carbon Capture & Sequestration Conference, Pittsburgh, Pennsylvania, May 10–13, 2010.

Holubnyak, Y.I., Knudsen, D.J., Mibeck, B.A., Bremer, J.M., Smith, S.A., Sorensen, J.A., Gorecki, C.D., Steadman, E.N., and Harju, J.A., 2010, Geochemical modeling of enhanced oil recovery and CO_2 storage at the Northwest McGregor oil field: Presented at the 9th Annual Carbon Capture & Sequestration Conference, Pittsburgh, Pennsylvania, May 10–13, 2010.

Holubnyak, Y.I., Rygalov, V., Smith, S.A., Sorensen, J.A., Steadman, E.N., and Harju, J.A., 2010, Introducing new statistical methods in geochemical kinetics modeling for better estimations of CO_2–water–rock interactions: Poster presented at the 9th Annual Carbon Capture & Sequestration Conference, Pittsburgh, Pennsylvania, May 10–13, 2010.

Holubnyak, Y.I., Knudsen, D.J., Mibeck, B.A., Bremer, J.M., Smith, S.A., Sorensen, J.A., Gorecki, C.D., Steadman, E.N., and Harju, J.A., 2010, Geochemical modeling of carbon dioxide injection into a carbonate formation in the northwest McGregor oil field for CO_2 storage and enhanced oil recovery (EOR): Poster presented at the American Association of Petroleum Geologists (AAPG) Annual Convention and Exhibition, New Orleans, Louisiana, April 11–14, 2010.

Holubnyak, Y.I., Hawthorne, S.B., Mibeck, B.A.F., Miller, D.J., Bremer, J.M., Sorensen, J.A., Steadman, E.N., and Harju, J.A., 2010, Modeling CO_2–H_2S–water–rock interactions at

Williston Basin reservoir conditions: Poster presented at the International Conference on Greenhouse Gas Control Technologies (GHGT-10), Amsterdam, The Netherlands, September 19–23, 2010.

Holubnyak, Y.I., Hawthorne, S.B., Mibeck, B.A., Miller, D.J., Bremer, J.M., Smith, S.A., Sorensen, J.A., Steadman, E.N., and Harju, J.A., 2010, Comparison of CO_2 and acid gas interactions with reservoir fluid and rocks at Williston Basin conditions, *in* Acid Gas Injection Symposium 2010, Calgary, Alberta, Canada, September 28–29, 2010, Proceedings.

Holubnyak, Y.I., Mibeck, B.A.F., Bremer, J.M., Smith, S.A., Gorecki, C.D., Sorensen, J.A., Steadman, E.N., and Harju, J.A., 2010, Geochemical modeling of huff 'n' puff oil recovery with CO_2 at the Northwest McGregor oil field, *in* Acid Gas Injection Symposium 2010, Calgary, Alberta, Canada, September 28–29, 2010, Proceedings.

Holubnyak, Y.I., Mibeck, B.A., Bremer, J.M., Smith, S.A., Sorensen, J.A., Gorecki, C.D., Steadman, E.N., and Harju, J.A., 2010, Investigation of geochemical interactions of carbon dioxide and carbonate formation in the Northwest McGregor oil field after enhanced oil recovery and CO_2 storage: Poster presented at the International Conference on Greenhouse Gas Control Technologies (GHGT-10), Amsterdam, The Netherlands, September 19–23, 2010.

Jensen, M.D., 2009, CO_2 pipeline basics: Presented at the Plains CO_2 Reduction (PCOR) Partnership Annual Meeting, St. Louis, Missouri, December 1–3, 2009.

Jensen, M.D., 2009, Deployable CO_2 capture technologies: Presented at the Plains CO_2 Reduction (PCOR) Partnership 2009 Annual Meeting, St. Louis, Missouri, December 1–3, 2009.

Jensen, M.D., 2010, Risks associated with capture, compression, and transport of CO_2: Presented at the Risk Management for CCS Projects Training Seminar, Calgary, Alberta, May 18, 2010.

Jensen, M.D., Pavlish, B.M., Pei, P., Leroux, K.M.B., Steadman, E.N., and Harju, J.A., 2010, Estimating the cost to capture, compress, and transport CO_2 from stationary sources in the PCOR Partnership region: Poster presented at the 9th Annual Carbon Capture & Sequestration Conference, Pittsburgh, Pennsylvania, May 10–13, 2010.

Klapperich, R.J., Gorecki, C.D., and McNemar, A., 2010, Regional Carbon Sequestration Partnership Water Working Group: Presented at the Water–Energy Sustainability Symposium 2010, Pittsburgh, Pennsylvania, September 26–29, 2010.

Knudsen, D.J., Liu, G., Gorecki, C.D., Sorensen, J.A., Smith, S.A., Steadman, E.N., and Harju, J.A., 2010, Modeling and simulation workflow for a fractured carbonate CO_2 huff'n'puff—a case study in the Williston Basin, North Dakota, USA: Poster presented at the 6th Institute of Mathematics and its Applications Conference on Modelling Permeable Rocks, Edinburgh, Scotland, United Kingdom, March 29 − April 1, 2010.

Knudsen, D.J., Gorecki, C.D., Bremer, J.M., Holubnyak, Y.I., Mibeck, B.A., Schmidt, D.D., Smith, S.A., Sorensen, J.A., Steadman, E.N., and Harju, J.A., 2010, Characterization and modeling of a CO_2 huff 'n' puff to predict and verify EOR production and CO_2 storage: Presented at the American Association of Petroleum Geologists (AAPG) Annual Convention & Exhibition, New Orleans, Louisiana, April 11–14, 2010.

Kutchko, B.G., Hawthorne, S.B., Strazisar, B.R., and Miller, D.J., 2009, H_2S–CO_2 reaction with hydrated Class H well cement under geologic sequestration conditions: Presented at the 2009 American Geophysical Union (AGU) Fall Meeting, San Francisco, California, December 14–18, 2009, Poster U41-0010.

Moffatt, D., Laundry, A., Sorensen, J.A., Smith, S.A., Steadman, E.N., and Harju, J.A., 2010, The Fort Nelson carbon capture and storage feasibility project—a program for large-scale geologic storage of CO_2 from a natural gas-processing plant in British Columbia, Canada: Poster presented at the International Conference on Greenhouse Gas Control Technologies (GHGT-10), Amsterdam, The Netherlands, September 19–23, 2010.

Ness, R., and Daly, D.J., 2010, The energy–water connection—keeping the Bakken pump primed: Presented at the North Dakota Petroleum Council Teacher Education Workshop, Bismarck, North Dakota, June 9, 2010.

Peck, W.D., 2009, Regional characterization and the decision support system: Presented at the Plains CO_2 Reduction (PCOR) Partnership 2009 Annual Meeting, St. Louis, Missouri, December 1–3, 2009.

Peck, W.D., and Steadman, E.N., 2010, The Plains CO_2 Reduction (PCOR) Partnership—carbon capture and storage demonstration activities: Presented at the American Association of Petroleum Geologists Rocky Mountain Section Meeting, Durango, Colorado, June 13–16, 2010.

Schmidt, D.D., 2009, Carbon storage in lignite coal: Presented at the Regional Carbon Sequestration Partnership (RCSP) Annual Review Meeting, Pittsburgh, Pennsylvania, November 16–19, 2009.

Schmidt, D.D., 2009, Carbon storage in lignite coal: Presented at the Plains CO_2 Reduction (PCOR) Partnership 2009 Annual Meeting, St. Louis, Missouri, December 1–3, 2009.

Schmidt, D.D., Botnen, L.S., Dobroskok, A.A., Rovenko, R.J., Knutson, R.D., Steadman, E.N., Harju, J.A., and Nakles, D.V., 2010, CO_2 storage pilot study for lignite coal: Presented at the 9th Annual Carbon Capture & Sequestration Conference, Pittsburgh, Pennsylvania, May 10–13, 2010.

Smith, S.A., Steadman, E.N., Harju, J.A., and Sorensen, J.A., 2009, Zama acid gas EOR, CO_2 and monitoring project: Presented at the Regional Carbon Sequestration Partnership (RCSP) Annual Review Meeting, Pittsburgh, Pennsylvania, November 16–19, 2009.

Smith, S.A., 2009, Zama acid gas EOR, CO_2 storage and monitoring project: Presented at the Plains CO_2 Reduction (PCOR) Partnership 2009 Annual Meeting, St. Louis, Missouri, December 1–3, 2009.

Smith, S.A., 2010, Geomechanical testing and modeling of cap rock integrity in an acid gas EOR/sequestration project, Zama, Alberta, Canada: Presented at the Caprocks and Seals for Geologic Carbon Sequestration Workshop, Pacific Grove, California, January 12–15, 2010.

Smith, S.A., Sorensen, J.A., Steadman, E.N., and Harju, J.A., 2010, Zama acid gas EOR, CO_2 sequestration, and monitoring project: Poster presented at the American Association of Petroleum Geologists (AAPG) Annual Convention and Exhibition, New Orleans, Louisiana, April 11–14, 2010.

Smith, S.A., 2010, Overview of Phase II PCOR Partnership MVA activities: Presented at the International Energy Agency Greenhouse Gas (IEAGHG) Monitoring Network Meeting, Natchez, Mississippi, May 6–8, 2010.

Smith, S.A., 2010, Overview of the PCOR Partnership's Phase III field demonstration—Spectra Energy's Fort Nelson carbon capture and storage (CCS) feasibility project: Presented at the International Energy Agency Greenhouse Gas (IEAGHG) Monitoring Network Meeting, Natchez, Mississippi, May 6–8, 2010.

Smith, S.A., 2010, Zama acid gas EOR, CO_2 storage and monitoring project: Presented at the IEAGHG Weyburn-Midale CO_2 Monitoring and Storage Project Meeting, Saskatoon, Saskatchewan, June 21–23, 2010.

Smith, S.A., Sorensen, J.A., Steadman, E.N., and Harju, J.A., 2010, Zama acid gas EOR, CO_2 sequestration, and monitoring project: Presented at the 9th Annual Carbon Capture & Sequestration Conference, Pittsburgh, Pennsylvania, May 10–13, 2010.

Smith, S.A., 2010, Zama acid gas EOR, CO_2 storage and monitoring project: Presented at the International Conference on Greenhouse Gas Control Technologies (GHGT-10), Amsterdam, The Netherlands, September 19–23, 2010.

Sorensen, J.A., Schmidt, D.D., and Smith, S.A., 2009, Phase II Williston Basin Northwest McGregor oil field huff 'n' puff test: Presented at the Regional Carbon Sequestration Partnership (RCSP) Annual Review Meeting, Pittsburgh, Pennsylvania, November 16–19, 2009.

Sorensen, J.A., 2009, Phase II Williston Basin Northwest McGregor oil field huff 'n' puff test: Presented at the Plains CO_2 Reduction (PCOR) Partnership 2009 Annual Meeting, St. Louis, Missouri, December 1–3, 2009.

Sorensen, J.A., Knudsen, D.J., Pluemer, B., Butsch, R., Malkewicz, N., Mahoney, K., Peters, D., Nutt, L., Smith, S.A., Steadman, E.N., and Harju, J.A., 2010, Northwest McGregor field CO_2 huff 'n' puff—a case study of the application of selected geophysical techniques for CO_2

monitoring in a deep carbonate reservoir: Presented at the 9th Annual Carbon Capture & Sequestration Conference, Pittsburgh, Pennsylvania, May 10–13, 2010.

Sorensen, J.A., Schmidt, D.D., Knudsen, D.J., Smith, S.A., Gorecki, C.D., Steadman, E.N., and Harju, J.A., 2010, Results of the Plains CO_2 Reduction Partnership's Phase II demonstration in the Northwest McGregor oil field, North Dakota: Presented at the 9th Annual Carbon Capture & Sequestration Conference, Pittsburgh, Pennsylvania, May 10–13, 2010.

Sorensen, J.A., Knudsen, D.J., Smith, S.A., Gorecki, C.D., Steadman, E.N., and Harju, J.A., 2010, Northwest McGregor field CO_2 huff 'n' puff—a case study of the application of field monitoring and modeling techniques for CO_2 prediction and accounting: Poster presented at the International Conference on Greenhouse Gas Control Technologies (GHGT-10), Amsterdam, The Netherlands, September 19–23, 2010.

Steadman, E.N., 2009, Plains CO_2 Reduction (PCOR) Partnership Phase III overview: Presented at the Regional Carbon Sequestration Partnership (RCSP) Annual Review Meeting, Pittsburgh, Pennsylvania, November 16–19, 2009.

Steadman, E.N., 2009, Carbon management—terrestrial and geologic sequestration: Presented at the Plains CO_2 Reduction (PCOR) Partnership 2009 Annual Meeting, St. Louis, Missouri, December 1–3, 2009.

Steadman, E.N., and Harju, J.A., 2009, PCOR Partnership Phase II—program management overview/conclusions: Presented at the Plains CO_2 Reduction (PCOR) Partnership 2009 Annual Meeting, St. Louis, Missouri, December 1–3, 2009.

Steadman, E.N., 2009, PCOR Partnership—Phase III overview: Presented at the Plains CO_2 Reduction (PCOR) Partnership Annual Meeting, St. Louis, Missouri, December 1–3, 2009.

Steadman, E.N., and Harju, J.A., 2009, Fort Nelson carbon capture and storage (CCS) project: Presented at the Third Carbon Sequestration Leadership Forum (CSLF) Ministerial Meeting, London, England, United Kingdom, October 11–14, 2009.

Steadman, E.N., Harju, J.A., Peck, W.D., and Sorensen, J.A., 2009, Fort Nelson carbon capture and storage (CCS) project: Presented at the Plains CO_2 Reduction (PCOR) Partnership Annual Meeting, St. Louis, Missouri, December 1–3, 2009.

Steadman, E.N., Harju, J.A., Peck, W.D., and Sorensen, J.A., 2009, Fort Nelson carbon capture and storage (CCS) project: Presented at the Third Carbon Sequestration Leadership Forum (CSLF) Ministerial Meeting, London, England, United Kingdom, October 11–14, 2009.

Steadman, E.N., and Harju, J.A., 2010, Plains CO_2 Reduction (PCOR) Partnership update: Presented at EUEC 2010: 13th Annual Energy & Environment Conference, Phoenix, Arizona, February 1–3, 2010.

Steadman, E.N., Harju, J.A., and Olle, T., 2010, The Plains CO_2 Reduction (PCOR) Partnership: Presented to Jim Markowsky, U.S. Department of Energy Assistant Secretary for Fossil Energy, Washington, D.C., March 23, 2010.

Steadman, E.N., 2010, Plains CO_2 Reduction (PCOR) Partnership update: Presented at the Geological Society of America North-Central Section (44th Annual) and South-Central (44th Annual) Joint Meeting, Branson, Missouri, April 11–13, 2010.

Steadman, E.N., 2010, Reducing industry's carbon footprint—exploring progress made in carbon capture and storage in BC: Presented at The Canadian Institute's 13th BC Natural Gas Symposium, Vancouver, British Columbia, June 2–3, 2010.

Steadman, E.N., and Harju, J.A., 2010, Characterization and monitoring for the carbon capture and storage (CCS) demonstrations of the Plains CO_2 Reduction (PCOR) Partnership: Presented at the 2010 Geological Carbon Sequestration Site Integrity: Characterization and Monitoring Science and Technology Workshop, Columbus, Ohio, June 7–8, 2010.

Steadman, E.N., and Harju, J.A., 2010, The Plains CO_2 Reduction (PCOR) Partnership—carbon capture and storage demonstration activities: Presented at the 9th Annual Carbon Capture & Sequestration Conference, Pittsburgh, Pennsylvania, May 10–13, 2010.

Steadman, E.N., and Harju, J.A., 2010, The Plains CO_2 Reduction (PCOR) Partnership—collaborative U.S.–Canada carbon capture and storage demonstration activities: Presented at the 9th Annual Carbon Capture & Sequestration Conference, Pittsburgh, Pennsylvania, May 10–13, 2010.

Steadman, E.N., Harju, J.A., Sorensen, J.A., Gorecki, C.D, and Smith, S.A., 2010, CO_2-based enhanced oil recovery experience in the PCOR Partnership: Presented at the U.S. Department of Energy/Masdar Cooperation Workshop, Pittsburgh, Pennsylvania, June 25, 2010.

Steadman, E.N., 2010, Coproduction of hydrogen with power, fuels, and chemicals from fossil fuels: Presented at Advancing the Hydrogen Economy Action Summit III, Grand Forks, North Dakota, September 13, 2010.

Steadman, E.N., 2010, Plains CO_2 Reduction (PCOR) Partnership update: Presented at the Partnership for CO_2 Capture Phase II kickoff meeting, Grand Forks, North Dakota, August 11, 2010.

Steadman, E.N., and Harju, J.A., 2010, Plains CO_2 Reduction (PCOR) Partnership update: Presented at the International Conference on Greenhouse Gas Control Technologies (GHGT-10), Amsterdam, The Netherlands, September 19–23, 2010.

Wildgust, N., and Gorecki, C.D., 2010, Development of storage coefficients for carbon dioxide storage in deep saline formations: Poster presented at the International Conference on Greenhouse Gas Control Technologies (GHGT-10), Amsterdam, The Netherlands, September 19–23, 2010.

Papers and Book Chapters

Botnen, L.S., Sorensen, J.A., Steadman, E.N., Harju, J.A., Ayash, S.C., Giry, E.F., Frenette, R., Meyer, V., and Moffatt, D.J. , 2010, A new risk management methodology for large-scale CO_2 storage—application to the Fort Nelson carbon capture and storage feasibility project: Paper for the International Conference on Greenhouse Gas Control Technologies (GHGT-10), Amsterdam, The Netherlands, September 19–23, 2010.

Bremer, J.M., Mibeck, B.A.F., Huffman, B.W., Gorecki, C.D., Sorensen, J.A., Schmidt, D.D., and Harju, J.A., 2010, Mechanical and geochemical assessment of hydraulic fracturing proppants exposed to carbon dioxide and hydrogen sulfide, *in* Proceedings of the Canadian Unconventional Resources & International Petroleum Conference: Calgary, Alberta, October 19–21, 2010, No. CSUG/SPE 136550.

Daly, D.J., Bradbury, J., Garrett, G., Greenberg, S., Myhre, R., Peterson, T., Tollefson, L., Wade, S., and Sacuta, N., 2010, Road-testing the outreach best practices manual—applicability for implementation of the development phase projects by the regional carbon sequestration partnerships: Paper for the International Conference on Greenhouse Gas Control Technologies (GHGT-10), Amsterdam, The Netherlands, September 19–23, 2010.

Hawthorne, S.B., Miller, D.J., Holubnyak, Y.I., Harju, J.A., Kutchko, B.G., and Strazisar, B.R., 2010, Experimental investigations of the effects of acid gas (H_2S/CO_2) exposure under geological sequestration conditions: Paper for the International Conference on Greenhouse Gas Control Technologies (GHGT-10), Amsterdam, The Netherlands, September 19–23, 2010.

Holubnyak, Y.I., Hawthorne, S.B., Mibeck, B.A., Miller, D.J., Bremer, J.M., Smith, S.A., Sorensen, J.A., Steadman, E.N., and Harju, J.A., 2010, Comparison of CO_2 and acid gas interactions with reservoir fluid and rocks at Williston Basin conditions, *in* Advances in Natural Gas Engineering, v. 2.: Salem, Massachusetts, Scrivener Publishing [in press].

Holubnyak, Y.I., Mibeck, B.A.F., Bremer, J.M., Smith, S.A., Sorensen, J.A., Gorecki, C.D., Steadman, E.N., and Harju, J.A., 2010, Geochemical modeling of huff 'n' puff oil recovery with CO_2 at the Northwest McGregor oil field, *in* Advances in Natural Gas Engineering, v. 2.: Salem, Massachusetts, Scrivener Publishing [in press].

Holubnyak, Y.I., Hawthorne, S.B., Mibeck, B.A.F., Miller, D.J., Bremer, J.M., Sorensen, J.A., Steadman, E.N., and Harju, J.A., 2010, Modeling CO_2–H_2S–water–rock interactions at Williston Basin reservoir conditions: Paper for the International Conference on Greenhouse Gas Control Technologies (GHGT-10), Amsterdam, The Netherlands, September 19–23, 2010.

Holubnyak, Y.I., Mibeck, B.A., Bremer, J.M., Smith, S.A., Sorensen, J.A., Gorecki, C.D., Steadman, E.N., and Harju, J.A., 2010, Investigation of geochemical interactions of carbon dioxide and carbonate formation in the Northwest McGregor oil field after enhanced oil

recovery and CO_2 storage: Paper for the International Conference on Greenhouse Gas Control Technologies (GHGT-10), Amsterdam, The Netherlands, September 19–23, 2010.

Harju, J.A., Steadman, E.N., and Anagnost, K.K., 2010, Dividing responsibility into partnerships across the country—The Plains CO_2 Reduction (PCOR) Partnership – one of the U.S. Department of Energy's regional carbon sequestration partnerships: Presented at Carbon Capture and Storage World Australia 2010, Melbourne, Australia, June 21–23, 2010.

Schmidt, D.D., Botnen, L.S., Dobroskok, A.A., Rovenko, R.J., Knutson, R.D., Steadman, E.N., Harju, J.A., and Nakles, D.V., 2010, CO_2 storage pilot study for lignite coal, *in* 9th Annual Conference on Carbon Capture and Sequestration: Pittsburgh, Pennsylvania, May 10–13, 2010: Proceedings.

Smith, S.A., Sorensen, J.A., Steadman, E.N., Harju, J.A., and Fischer, D.W., 2009, Estimates of CO_2 storage capacity in selected oil fields of the northern Great Plains region of North America, in Grobe, M., Pashin, J.C., and Dodge, R.L., eds., Carbon dioxide sequestration in geological media—state of the science [AAPG studies in geology], v. 59, p. 87–97.

Smith, S.A., Sorensen, J.A., Steadman, E.N., and Harju, J.A., 2010, Zama acid gas EOR, CO_2 sequestration, and monitoring project, *in* 9th Annual Conference on Carbon Capture and Sequestration: Pittsburgh, Pennsylvania, May 10–13, 2010: Proceedings.

Smith, S.A., Sorensen, J.A., Steadman, E.N., Harju, J.A., and Ryan, D., 2010, Zama acid gas EOR, CO_2 sequestration, and monitoring project: Paper for the International Conference on Greenhouse Gas Control Technologies (GHGT-10), Amsterdam, The Netherlands, September 19–23, 2010.

Sorensen, J.A., Botnen, L.S., Steadman, E.N., Harju, J.A., Helms, L.D., and Fischer, D.W., 2009, Unitization of geologic media for the purpose of monetizing geologic sequestration credits, in Grobe, M., Pashin, J.C., and Dodge, R.L., eds., Carbon dioxide sequestration in geological media—state of the science [AAPG studies in geology], v. 59, p. 707–715.

Sorensen, J.A., Smith, S.A., Dobroskok, A.A., Peck, W.D., Belobraydic, M.L., Kringstad, J.J., and Zeng, Z., 2009, Carbon dioxide storage potential of the Broom Creek Formation in North Dakota—a case study in site characterization for large-scale sequestration, in Grobe, M., Pashin, J.C., and Dodge, R.L., eds., Carbon dioxide sequestration in geological media—state of the science [AAPG studies in geology], v. 59, p. 279–296.

Sorensen, J.A., Schmidt, D.D., Knudsen, D.J., Smith, S.A., Gorecki, C.D., Steadman, E.N., and Harju, J.A., 2010, Results of the Plains CO_2 Reduction Partnership's Phase II demonstration in the Northwest McGregor oil field, North Dakota, *in* 9th Annual Conference on Carbon Capture and Sequestration: Pittsburgh, Pennsylvania, May 10–13, 2010: Proceedings.

Sorensen, J.A., Schmidt, D.D., Knudsen, D.J., Smith, S.A., Gorecki, C.D., Steadman, E.N., and Harju, J.A., 2010, Northwest McGregor field CO_2 huff 'n' puff—a case study of the application of field monitoring and modeling techniques for CO_2 prediction and accounting:

Paper for the International Conference on Greenhouse Gas Control Technologies (GHGT-10), Amsterdam, The Netherlands, September 19–23, 2010.

Sorensen, J.A., Smith, S.A., Steadman, E.N., Harju, J.A., Moffatt, D., and Laundry, A., 2010, The Fort Nelson carbon capture and storage feasibility project— a program for large-scale geologic storage of CO_2 from a natural gas-processing plant in British Columbia, Canada: Paper for the International Conference on Greenhouse Gas Control Technologies (GHGT-10), Amsterdam, The Netherlands, September 19–23, 2010.

Steadman, E.N., Anagnost, K.K., Botnen, B.W., Botnen, L.S., Daly, D.J., Gorecki, C.D., Harju, J.A., Jensen, M.D., Peck, W.D., Romuld, L., Smith, S.A., Sorensen, J.A., and Votava, T.J., 2010, The Plains CO_2 Reduction (PCOR) Partnership—developing carbon management options for the central interior of North America: Paper for the International Conference on Greenhouse Gas Control Technologies (GHGT-10), Amsterdam, The Netherlands, September 19–23, 2010.

Wildgust, N., Gorecki, C.D., and Bremer, J.M., 2010, An overview of the IEA Greenhouse Gas R&D Programme regional geologic storage capacity studies: Paper for the International Conference on Greenhouse Gas Control Technologies (GHGT-10), Amsterdam, The Netherlands, September 19–23, 2010.