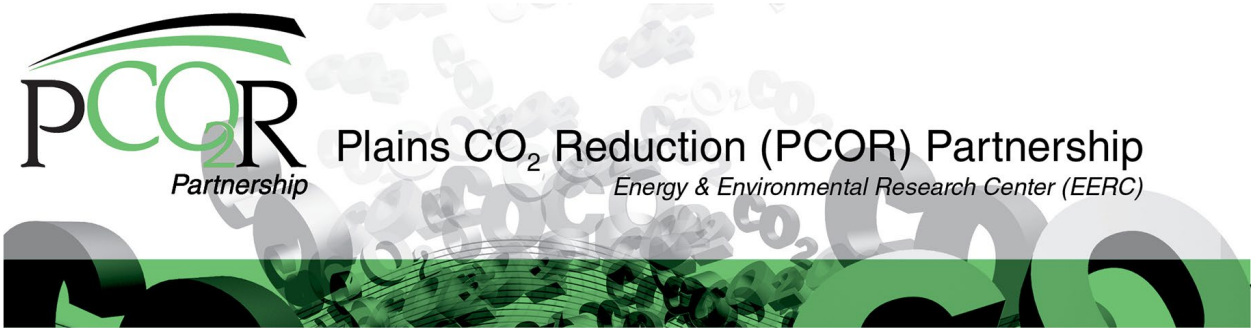

ANNUAL ASSESSMENT REPORT

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

(for the period October 1, 2014, through September 30, 2015)

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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 (DOE) National Energy Technology Laboratory (NETL) in 2003 as part of a national plan to mitigate greenhouse gas emissions. The PCOR Partnership is led and managed by the Energy & Environmental Research Center (EERC) at the University of North Dakota in Grand Forks, North Dakota, and includes almost 100 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 10-year (2007–2017) development phase, is an extension of the characterization (Phase I) and validation (Phase II) phases and is intended to confirm that commercial-scale carbon dioxide (CO_2) capture, transportation, injection, and storage can be achieved safely, permanently, and economically over extended periods in the PCOR Partnership region.

The Phase III efforts of the PCOR Partnership in Program Year (PY) 8 (October 1, 2014 – September 30, 2015) include 1) looking at the feasibility of developing a CO_2 storage program incidental to a commercial enhanced oil recovery (EOR) operations at Denbury Resource Inc.'s Bell Creek Field in southeastern Montana, 2) assisting SaskPower and the Petroleum Technology Research Centre (PTRC) with CO_2 storage modeling and monitoring at the Aquistore site, 3) continuing to gather regional characterization data to verify the ability of target formations to store CO_2, 4) facilitating the development of infrastructure to transport CO_2 from sources to injection sites, 5) facilitating sensible development of the rapidly evolving North American regulatory and permitting framework, 6) developing opportunities for PCOR Partnership partners to capture and store CO_2, 7) continuing collaboration with other RCSPs, and 8) providing outreach and education for CO_2 capture and storage stakeholders and the general public. The EERC previously provided monitoring, verification, and accounting (MVA) and risk management support for Spectra Energy's Fort Nelson Carbon Capture and Storage (CCS) Feasibility Project, which would have involved the injection of CO_2 captured from one of the largest gas-processing plants in North America into a saline formation in northeastern British Columbia. While significant progress has been made with respect to project planning, MVA, and risk analysis, the Fort Nelson CCS Feasibility Project is currently lacking a commercial driver to move it forward and, as such, is on indefinite hold. In place of continued efforts at Fort Nelson, scope and budget have been allocated to continuing support of the Aquistore Project.

Significant progress was made in PY8 on the Bell Creek demonstration project. **CO_2 injection continued, and as of July 2015, over 2,000,000 cumulative metric tons of associated CO_2 storage was recorded**! Efforts were focused on continued collection of groundwater- and soil gas-sampling data, completing two repeat 3-D seismic surveys and a repeat 3-D vertical seismic profile (VSP) survey, completing the analysis of the first large-scale repeat pulsed-neutron logging

(PNL) campaign post-significant CO_2 injection, and continuing training for and development of models and simulation activities. Over 2 years of near-surface assurance monitoring has now been completed. Integration and interpretation of the 3-D baseline surface seismic data lend support to a new depositional model.

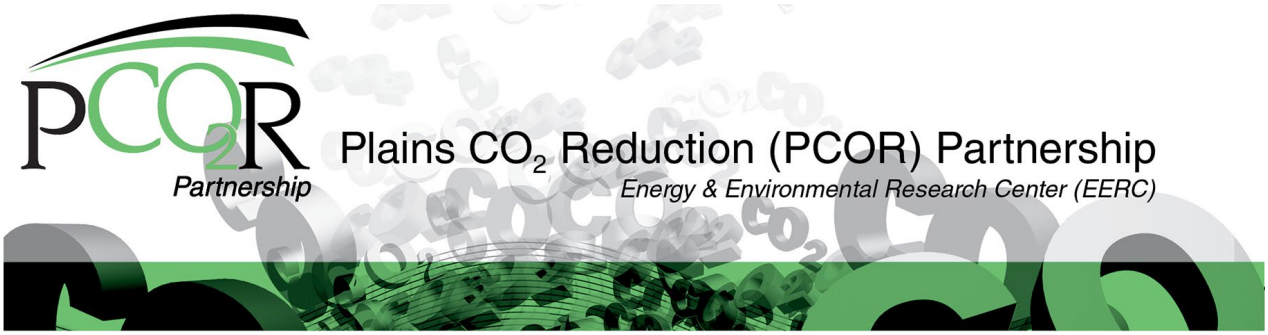
The PCOR Partnership submitted 20 abstracts, prepared ten conference papers, gave 61 presentations, achieved 15 milestones, completed 15 deliverable/milestone reports (12 were finalized), and prepared two value-added products and 16 progress reports. The annual membership meeting was held in Chicago, Illinois, and attracted 71 attendees representing 40 organizations.

The PCOR Partnership is playing an active part in the revision/redevelopment of DOE Carbon Storage Project best practices manuals (BPMs). There will be five BPMs, and they are due in March and May 2016. PCOR Partnership personnel participated in conference calls and Webinars with the working groups tasked with updating each BPM. PCOR Partnership personnel worked on reviewing and commenting on the existing BPMs and preparing revisions. Efforts will continue into PY9.

Overall, ten tasks continued to effectively support program goals in PY8. In addition to the foregoing, regional characterization continued, and over 440 significant CO_2 sources (greater than 100,000 metric tons), producing 340 million tonnes annually, were verified within the region. Outreach activities included distribution of print materials, oral and poster presentations, Web site updates, and documentary broadcasts. Since program inception, over 5700 PCOR Partnership atlases have been distributed, along with over 10,000 documentary DVDs. The Seventh Annual Regulatory Roundup was held in summer 2015, and the PCOR Partnership is assisting in understanding the U.S. Environmental Protection Agency's underground injection control rule related to transition of Class II enhanced oil or gas recovery wells to Class VI. The RCSP Water Working Group was active, holding its seventh annual meeting in August 2015, and is leading the effort to create and edit a special issue of the *International Journal of Greenhouse Gas Control* focused on the issues at the nexus of water and CCS. In addition, numerous activities in relation to the Petroleum Technology Research Centre Aquistore project (near Estevan, Saskatchewan) continued, including assisting with a press release and filming the Aquistore ribbon-cutting ceremony associated with CO_2 injection commencement, updating the geologic model and running predictive simulations, and completing analyses of core collected to develop an understanding of the mineralogical composition and petrophysical properties of the rocks below the site.

CO_2 injection at Bell Creek will continue in PY9. Operational monitoring and modeling activities will also 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. Of significant note, a 6-month, $4.5 million extension to Budget Period (BP) 4 was awarded on September 15, 2015. The additional time and funding will be used to extend and enhance Task 4 – Characterization and Modeling; Task 9 – Operational Monitoring and Modeling, specifically for Bell Creek activities; and attendant activities under Task 13. The BP4 extension moves the start of BP5 to April 2016. In PY9, ten tasks will continue to be implemented (Tasks 5, 7, 8, 15, and 16 are completed) and Tasks 10 and 11 will be initiated.

This report presents an update of Phase III PCOR Partnership activities from October 1, 2014, through September 30, 2015 (PY8) and planned activities for the following year.



ANNUAL ASSESSMENT REPORT

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 and managed by the Energy & Environmental Research Center (EERC) at the University of North Dakota (UND) in Grand Forks, North Dakota, and includes almost 100 stakeholders from the public and private sector in Phase III. The Phase III membership as of September 30, 2015, 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 PCOR Partnership falls within the infrastructure element of NETL's Carbon Storage Program and is a government–industry effort tasked with determining the most suitable technologies, regulations, and infrastructure needs for carbon capture, utilization, and storage (CCUS) on the North American continent.

The PCOR Partnership Program is implemented in three phases:

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

The PCOR Partnership's efforts are in support of NETL's Carbon Storage Program by helping to develop technologies to store carbon dioxide (CO_2) in order to reduce greenhouse gas (GHG) emissions without adversely influencing energy use or hindering economic growth.

The PCOR Partnership's efforts will help enable technologies to overcome a multitude of economic, social, and technical challenges, including cost-effective 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.

Table 1. PCOR Partnership Membership Phase III (October 1, 2007 – present, inclusive)

DOE NETL	Great River Energy	North Dakota Natural Resources Trust
UND EERC	Halliburton	North Dakota Petroleum Council
Abengoa Bioenergy New Technologies	Hess Corporation	North Dakota Pipeline Authority
Air Products and Chemicals, Inc.	Huntsman Corporation	Omaha Public Power District
Alberta Department of Energy	Husky Energy Inc.	Otter Tail Power Company
Alberta Department of Environment	Indian Land Tenure Foundation	Outsource Petrophysics, Inc.
Alberta Innovates – Technology Futures	Interstate Oil and Gas Compact Commission	Oxand Risk & Project Management Solutions
ALLETE	Iowa Department of Natural Resources	Peabody Energy
Ameren Corporation	Lignite Energy Council	Petroleum Technology Research Centre
American Coalition for Clean Coal Electricity	Manitoba Geological Survey	Petroleum Technology Transfer Council
American Lignite Energy	Marathon Oil Company	Pinnacle, a Halliburton Service
Apache Canada Ltd.	MBI Energy Services	Prairie Public Broadcasting
Aquistore	MEG Energy Corporation	Pratt & Whitney Rocketdyne, Inc.
Baker Hughes Incorporated	Melzer Consulting	Praxair, Inc.
Basin Electric Power Cooperative	Minnesota Power	Ramgen Power Systems, Inc.
BillyJack Consulting Inc.	Minnkota Power Cooperative, Inc.	RPS Energy Canada Ltd.
Biorecro AB	Missouri Department of Natural Resources	Saskatchewan Ministry of Industry and Resources
Blue Source, LLC	Missouri River Energy Services	SaskPower
BNI Coal, Ltd.	Montana–Dakota Utilities Co.	Schlumberger
British Columbia Ministry of Energy, Mines, and Petroleum Resources	Montana Department of Environmental Quality	Sejong University
British Columbia Oil and Gas Commission	National Commission on Energy Policy	Shell Canada Limited
C12 Energy, Inc.	Natural Resources Canada	Spectra Energy
The CETER Group, Ltd.	Nebraska Public Power District	Suncor Energy Inc.
Computer Modelling Group Ltd.	North American Coal Corporation	TAQA North, Ltd.
Continental Resources, Inc.	North Dakota Department of Commerce Division of Community Services	TGS Geological Products and Services
Dakota Gasification Company	North Dakota Department of Health	University of Alberta
Denbury Onshore LLC	North Dakota Geological Survey	University of Regina
Eagle Operating, Inc.	North Dakota Industrial Commission Department of Mineral Resources, Oil and Gas Division	WBI Energy, Inc.
Eastern Iowa Community College District	North Dakota Industrial Commission Lignite Research, Development and Marketing Program	Weatherford Advanced Geotechnology
Enbridge Inc.	North Dakota Industrial Commission Oil and Gas Research Council	Western Governors' Association
Encore Acquisition Company		Westmoreland Coal Company
Energy Resources Conservation Board/ Alberta Geological Survey		Wisconsin Department of Agriculture, Trade and Consumer Protection
Environment Canada		Wyoming Office of State Lands and Investments
Excelsior Energy Inc.		Xcel Energy
Great Northern Project Development, LP		

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 storage 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 storage demonstration projects in the region.

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

BP3: October 1, 2007 – September 30, 2009
BP4: October 1, 2009 – March 31, 2016
BP5: April 1, 2016 – September 30, 2017

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) facilitate the establishment of 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 development phase (Phase III) goal is implementation of large-scale field testing involving approximately 1 million metric tons of CO_2 per project. Each of the RCSP 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 participated in two large-scale demonstration projects. The sites are located 1) in Denbury Resources Inc.'s (Denbury's) Bell Creek oil field in Powder River County, southeastern Montana, and 2) near Spectra Energy's (Spectra's) Fort Nelson gas-processing facility, situated near Fort Nelson, British Columbia, Canada (currently inactive) (Figure 1).

In Program Year (PY) 8, CO_2 injection continued at the Bell Creek test site, and over 2 million metric tons of total gas (composition of approximately 96% CO_2) had been purchased by Denbury. Efforts were focused on continued collection of groundwater- and soil gas-sampling data, completing two repeat 3-D seismic surveys and a repeat 3-D vertical seismic profile (VSP) survey, completing the analysis of the first large-scale repeat pulsed-neutron logging (PNL) campaign post-significant CO_2 injection, and continuing training for and development of models and simulation activities. Over 2 years of near-surface assurance monitoring has now been completed.

In collaboration with Spectra, the PCOR Partnership is supporting the evaluation of the feasibility of a large-scale, integrated carbon capture and storage (CCS) project near Spectra'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. The PCOR Partnership's monitoring, verification, and accounting (MVA) efforts will help Spectra determine whether deep underground saline reservoirs and associated infrastructure in the Fort Nelson area are appropriate for CCS. Although the Fort Nelson demonstration project was placed on indefinite hold until Spectra can establish a business case for the project, the PCOR Partnership prepared a comprehensive summary of its characterization, modeling and simulation, and risk assessment activities into a best practices manual (BPM), and the information acquired and analyzed suggests that the Fort Nelson area has sink and seal conditions that make it an exceptional candidate location for large-scale CCS.

Figure 1. Location of large-scale sites with PCOR Partnership Phase III participation.

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) support Spectra's feasibility study of a 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 storage options for the PCOR Partnership region, characterizing the technical issues, enhancing the public's understanding of CO_2 storage, identifying the most promising opportunities for storage in the region, and detailing an action plan for the demonstration of regional CO_2 storage opportunities.

The PCOR Partnership is achieving its Phase III mission through a series of 16 tasks, as shown in Figure 2. These tasks include 1) Regional Characterization; 2) Public Outreach and Education; 3) Permitting and National Environmental Policy Act (NEPA) Compliance; 4) Site

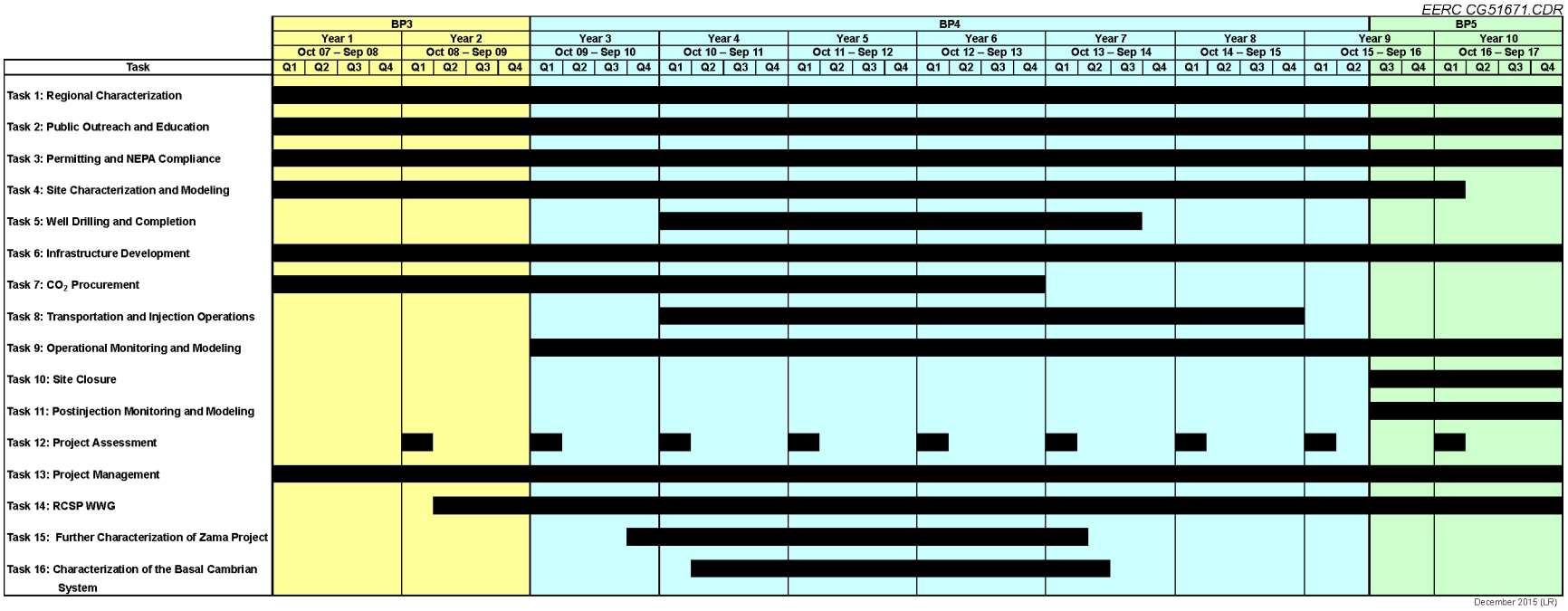


Figure 2. Phase III tasks.

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; 13) Project Management; 14) RCSP Water Working Group (WWG) Coordination; 15) Further Characterization of the Zama Acid Gas Enhanced Oil Recovery (EOR), CO_2 Storage, and Monitoring Project; and 16) Characterization of the Basal Cambrian System. Table 2 contains the responsibility matrix for these 16 tasks.

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	Charles D. Gorecki
Task 4 – Site Characterization and Modeling	James A. Sorensen
Task 5 – Well Drilling and Completion (completed)	John A. Hamling
Task 6 – Infrastructure Development	Melanie D. Jensen
Task 7 – CO_2 Procurement (completed)	John A. Harju
Task 8 – Transportation and Injection Operations	Melanie D. Jensen
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	Loreal V. Heebink
Task 13 – Project Management	Charles D. Gorecki
Task 14 – RCSP WWG Coordination	Ryan J. Klapperich
Task 15 – Further Characterization of the Zama Acid Gas EOR, CO_2 Storage, and Monitoring Project (completed)	Charles D. Gorecki
Task 16 – Characterization of the Basal Cambrian System (completed)	Wesley D. Peck

* To be announced.

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 PY8 (October 1, 2014 – September 30, 2015) of Phase III.

ASSESSMENT SUMMARY

In BP3, the focus of the program was to select two distinct and regionally significant geologic formations for large-volume (approximately 1 Mt of CO_2 a project) 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 and risk management support for the injection of up to 2 million metric tons/year CO_2 captured from one of the largest gas-processing plants in North America into a Devonian-aged carbonate formation in British Columbia, Canada. The Bell Creek

test site was selected in September 2009 and involves injection of CO_2 into a Cretaceous-aged sandstone formation in the Powder River Basin (PRB) in southeastern Montana for the purpose of CO_2 EOR and for the opportunity to study the associated storage of CO_2.

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, and 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 PY8. These included nine required reports, achievement of mandatory milestones, and four quarterly progress reports.

In August and September 2015, respectively, the PCOR Partnership participated in the RCSP annual project review meetings in Pittsburgh, Pennsylvania, and hosted the 2015 annual membership meeting in Chicago, Illinois. The EERC program manager presented an overview and update of Phase III PCOR Partnership activities in November 2013 before the IEA Greenhouse Gas R&D Programme (IEAGHG) expert panel review of the RCSPs to ensure that program goals are being met. Results of the review indicated that there was a unanimous view from the panel that the Bell Creek project has excellent scientific and technical merit combined with a comprehensive test program. It was also evident from the review that the project team covered each technical area comprehensively and was able to address all the technical points raised. Since the IEAGHG peer review in 2011, the PCOR Partnership established a Technical Advisory Board (TAB) to provide scientific and operational guidance which has aided the project. This was the only partnership that implemented this recommendation of the previous IEAGHG RCSP review. Other notable positive features were the wide-ranging public outreach program, a proven relationship with the operator, and an impressive reservoir characterization.

Throughout PY8, the PCOR Partnership was represented at 60 meetings/conferences/ workshops and submitted 20 abstracts. The PCOR Partnership had ten conference papers prepared and gave 61 presentations (oral and poster combined). In addition, it completed 15 deliverable/ milestone reports (12 were finalized), two value-added products, and 16 progress reports (monthlies and quarterlies combined) and prepared several conference call and meeting minutes.

The PCOR Partnership continued to post technical information about its program on its public Web site, which received over 24,000 site visits from 167 countries in PY8. The PCOR Partnership distributed over 700 documentary DVDs and 318 atlases in PY8. In addition, there were 57 telecasts of the documentaries on public television, and over 180 teachers heard the PCOR Partnership message and learned about CCUS. Through these efforts, the CO_2 storage community is kept informed of the PCOR Partnership's accomplishments and activities.

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. Spectra owns the gas-processing facility near the Fort Nelson site. CO_2 for the Bell Creek site comes from the ConocoPhillips Lost Cabin natural gas-processing and Shute Creek gas-processing facilities, and Denbury has secured the CO_2 from that facility until 2024.

Permitting of the sites required that the EERC complete DOE environmental questionnaires for both the Fort Nelson and Bell Creek demonstration projects. The Fort Nelson demonstration project received a categorical exclusion in 2010, and a categorical exclusion for the Bell Creek demonstration project was granted in 2011. A permitting action plan was prepared for the Bell Creek project in August 2011 and described the regulatory and permitting steps taken by the EERC and Denbury to conduct the project.

The PCOR Partnership continues to establish and maintain excellent relationships with regional regulatory authorities. EERC staff participates fully in Interstate Oil and Gas Compact Commission (IOGCC) efforts. Through the efforts of the IOGCC Carbon Geologic Storage (CGS) Task Force, the PCOR Partnership addressed issues relating to liability (operational and postoperational) that remain as barriers to the establishment of state and federal legal and regulatory frameworks for CCUS. Draft findings, recommendations, and guidance were developed in August 2013 and published online in September 2014. The PCOR Partnership also hosted its seventh annual regulatory workshop in July 2015, 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 the demonstration projects progress.

At the Bell Creek demonstration project, construction of the 232-mile Greencore CO_2 pipeline to the Bell Creek oil field was completed in late November 2012. Denbury began injecting CO_2 in the Bell Creek oil field in May 2013, and as of July 31, 2015, the most recent month of record, 2.383 million tonnes of total gas (composition of approximately 96% CO_2) has been purchased for injection into the Bell Creek Field, equating to an estimated 2.301 million tonnes of associated CO_2 storage, thereby surpassing a major RCSP Phase III metric of injection of 1 million metric tons of CO_2 per project.

The success of the PCOR Partnership Program will be evidenced by a region that has a supportive population, an accommodating regulatory environment and, ultimately, a vibrant commercial CCUS 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.

This 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 ten tasks (Tasks 1–4, 6, 8–9, and 12–14) that were active in BP4, PY8 (October 1, 2014 – September 30, 2015)

- Accomplishments achieved during BP4, PY8 (October 1, 2014 – September 30, 2015)

- Description of planned PY9 BP4 (October 1, 2015 – March 31, 2016) and BP5 (April 1, 2016 – September 30, 2016) activities

It should be noted that Tasks 10 and 11 will be initiated in BP5.

BP4, PY8 ACTIVITIES (2014–2015)

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. In February 2011, DOE approved moving former Subtask 1.4 to a newly created Task 15 and added a new task, Task 16, as shown in Figure 2. Out of the 16 tasks, ten tasks were active during BP4, PY8 (Task 7 concluded at the end of PY6, Tasks 5, 15, and 16 concluded during PY7, and Tasks 10 and 11 will not begin until BP5). The progress update for the active tasks is presented within this section. This Annual Assessment Report (Deliverable [D] 57) details activities beginning October 1, 2014, through the end of BP4, PY8, or September 30, 2015.

Charles D. Gorecki is the overall EERC 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 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, PY8 (October 1, 2014 – September 30, 2015) are addressed as follows.

Regional Characterization

The characterization of the region and its resources is vital to understanding the feasibility of moving from research to practice regarding storage of CO_2 in large-scale projects and implementation of practices regionwide. A necessary step toward the deployment of CCS is the development and understanding of the magnitude, distribution, and variability of the major stationary CO_2 sources and potential CO_2 storage targets. Using potential storage avenues available

coupled with the understanding of both the regional significance as well as in-depth knowledge of their availability to test the storage of CO_2 into available resources gives the opportunity to greatly reduce the impact of anthropogenic CO_2 while also being an economically feasible option across the region.

This report details the individual components used to determine the underlying potential for CO_2 storage in the PCOR Partnership region as well as characterization of the region as a whole to better understand what potential steps forward should be taken for commercialization of CCS not only in our region, but worldwide. CCS in geologic media is a technology that 1) is immediately applicable as a result of the experience gained in oil and gas exploration and production, deep waste disposal, and groundwater protection; 2) has large capacity, although unevenly distributed; and 3) has retention times of centuries to millions of years (1). Geologic storage of CO_2 is actively pursued at several locations around the world, including in the PCOR Partnership region.

Geologic media that have been identified as suitable for CO_2 storage are uneconomical coal beds, oil and gas reservoirs, and deep saline aquifers. Storage of CO_2 in coal beds has the smallest potential in terms of storage capacity and is an immature technology that has not yet been proven. Hydrocarbon reservoirs have the advantage of demonstrated storage capacity and confinement properties, but they need to be produced and depleted first (unless CO_2 is being used in EOR), and they are penetrated by many wells, which may diminish storage security. Deep saline aquifers have the advantage of being much more widespread, of significantly larger storage capacity, and generally present less risk of CO_2 leakage along existing wells because they are penetrated by fewer wells than hydrocarbon reservoirs (1).

Within the region, CO_2 storage resource potential amounts include 368–1220 billion tons in currently evaluated saline formations, 25 billion tons in depleted oil field reservoirs, 8 billion tons in unminable coal, and 1.71–10.26 billion tons in selected oil fields for EOR. Saline formations have the most significant storage potential, and with understanding each individual formation and its particular caveats, we can better understand how to utilize the information and create economically feasible plans for implementation of storage. By using both a broad and focused approach to characterization of these resources, we have the ability to look at the potential through a multistate/multiperspective as well as a site-specific approach.

The PCOR Partnership continues to refine the characterization of sources, geologic and terrestrial sinks, and infrastructure within the region. This continued regional characterization is refining CO_2 storage resource estimates for the project and providing context for extrapolating the results of the large-scale demonstrations (2).

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

The PCOR Partnership maintains a database of regional sources of CO_2 emissions and evaluates it on an annual basis. The database is an important part of assessing potential CO_2 capture–transportation–storage scenarios that could reduce GHG emissions in the PCOR Partnership region. The emission measurements compiled in this database are typically acquired through online databases of the U.S. Environmental Protection Agency (EPA) and Environment

Canada. The updated database shows that there are 443 significant (greater than 100,000 metric tons) CO_2 emission sources that emit 340 million tonnes on an annual basis. Figure 3 shows the locations of eight new facilities that were found to be missing from the data set and were, therefore, added to it (3).

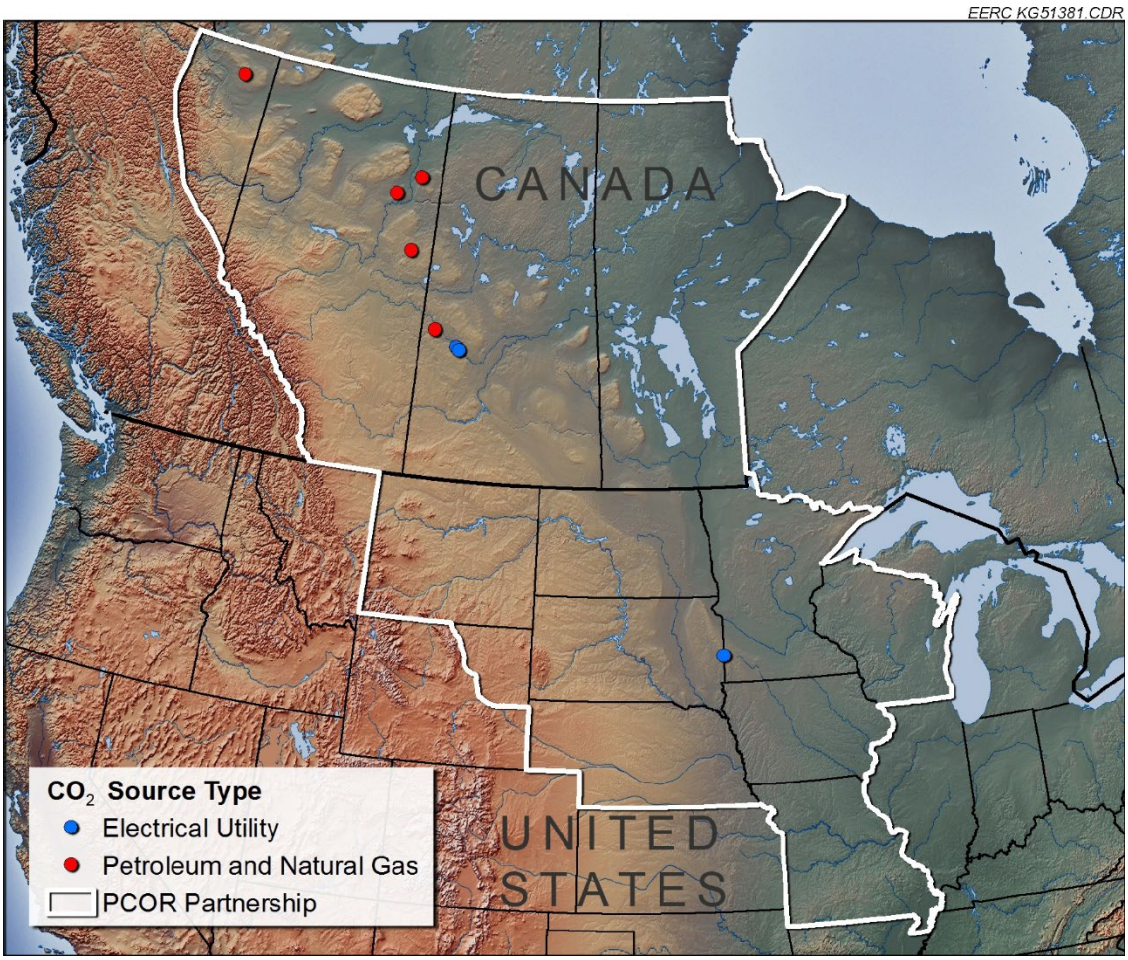


Figure 3. Location of the new facilities identified during the 2015 database update.

A journal article entitled "Improvements in the Application of CO_2 Storage Efficiency Values for Deep Saline Formations" was submitted for consideration to the *International Journal of Greenhouse Gas Control* in PY8. However, the requested revisions conflicted with an earlier publication from the 12th Greenhouse Gas Technologies (GHGT-12) Conference. Therefore, the article was withdrawn.

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. Efforts are under way to expand the number of assessed formations in these basins.

Through its close involvement with DOE and the international community with respect to the development and use of storage efficiency factors, the PCOR Partnership has accrued valuable insight into the methodologies for CO_2 storage resource and capacity estimations for deep saline formations. This insight has resulted in the development of a workflow that introduces intermediate storage efficiency factors that take into account increased levels of geologic reconnaissance (e.g., the geographic distribution of salinity and depth values) to generate refined CO_2 storage resource values for saline formations (4). This methodology is currently being applied to assess the Williston Basin.

A value-added report on the geologic characterization and CO_2 storage potential of the state of Nebraska, including the Cedar Hills sandstone and Amazon dolomite, continued in PY8 and should be finalized in PY9.

A value-added report on the geologic characterization and CO_2 storage potential of the Inyan Kara Formation was initiated in PY8 and should be finalized in PY9.

Relative Permeability of Williston Basin CO_2 Storage Sinks

Within the Williston Basin, multiple geologic formations have been identified as potential candidates for the injection and long-term storage of CO_2 captured from stationary industrial sources. Of particular interest for advanced characterization are the Inyan Kara, Broom Creek, Madison/Mission Canyon, and Deadwood Formations. These reservoirs represent both carbonate and clastic rock types. While each of these reservoirs has been evaluated with regard to its hydrocarbon resource, underground injection, or industrial process source water potential, there is little to no information specific to the response of the reservoir during the injection of CO_2.

To address this issue, the PCOR Partnership initiated a value-added laboratory effort to determine key petrophysical attributes of these reservoirs. Laboratory activities will be conducted to fully characterize existing samples with regard to mineralogy, porosity, pore size distribution, permeability, and CO_2/brine relative permeability. The work will provide a comparison of reservoir properties and their relationship to CO_2/brine relative permeability. Specific attributes, including pore size and distribution, air permeability, and fluid viscosities, will be compared from sample to sample to determine what similarities exist in the sample set as well as to existing results published in peer-reviewed literature. Results of this work will advance our understanding of the injectivity and storage potential of these reservoirs as well as provide baseline data for future geochemical evaluations.

Core intervals were selected at the North Dakota Geological Survey Core Library from several wells for laboratory characterization. Testing was initiated in PY8 and will be completed in PY9. A PCOR Partnership value-added report will be submitted to DOE NETL, and a peer-reviewed journal article will be prepared and submitted for publication. PCOR Partnership partner Stefan Bachu, Alberta Innovates – Technology Futures (AITF), will be a coauthor on the peer-reviewed paper.

Work with Geological Surveys/Oil and Gas Divisions

In PY8, regional characterization staff continued to work closely with the Montana Board of Oil and Gas (MBOG), the North Dakota Department of Mineral Resources, and the Wyoming Oil and Gas Conservation Commission to acquire updated cumulative oil production numbers for the fields and pools in the U.S. portion of the PCOR Partnership region.

PCOR Partnership Atlas

The *PCOR Partnership Atlas* provides an introduction to the concept of global climate change and CCUS as well as 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. Efforts to reinvent the *PCOR Partnership Atlas, 4th Edition*, were undertaken in PY4, and after the appropriate approvals were received, 1200 atlases were printed in June 2012. A new printing of 1250 copies of the *PCOR Partnership Atlas, 4th Edition, Revised*, was received in June 2013.

The atlas continues to serve as an excellent resource as well as a valuable outreach tool. It is distributed to partners, visitors, educators, libraries, and conference attendees and is available upon request, including via the public PCOR Partnership Web site. Approximately 318 atlases were distributed in PY8 (compared to 370 distributed in PY7). Overall, since its first printing in 2005, over 5700 atlases have been distributed.

Modifications and updates to the information in the atlas continued. The *PCOR Partnership Atlas, 5th Edition*, is anticipated to be complete in PY9 (August 31, 2016).

Updating the Decision Support System (DSS) Web Site (www2.undeerc.org/website/PCORP)

Modifications and refinement to the partners-only DSS are continually undertaken to ensure the timely dissemination of data and information as well as to help improve the quality and efficacy for our partners for their carbon management decisions.

The current DSS has been updated with CO_2 sources as well as oil fields, including previously abandoned fields in Montana. On November 25, 2014, the new and enhanced search tool for the GIS (geographic information system) application was moved to the "live" DSS (www2.undeerc.org/website/PCORP/DSS/). This advanced search tool was implemented to better serve the needs of the partners and to improve the ability to search using different attributes. With respect to sources, this tool will allow the user to search by the source type, source name, and source CO_2 amounts, including use of these same attributes to remove sources that do not fit certain criteria. For example, one can search for all ethanol plants and, from that search, eliminate any sources with a CO_2 output of less than 25,000 metric tons. There is also an option of exporting the remaining results. Searching the oil fields has now been broken down into oil fields and unitized oil fields and allows the user to search the oil fields by name.

In addition, the following activities continued in PY8.

- The various databases (oil fields, wells, gas plants) that ultimately feed the DSS were updated as well as the current GIS well files.

- New PCOR Partnership products are regularly added to the database once they are approved for release to partners. Currently, the database contains over 1240 products (an increase by over 120 products over PY7 [1120]) produced by the PCOR Partnership since its inception in 2003.

- The Partner Directory is a database-driven page that is continuously updated to include the partners' most recent contact information. As new partners join the PCOR Partnership, their company name and URL are updated.

It should be noted that the requirements for updated DSS reports (D9) in September 2013 and 2015 were deleted in September 2012. In PY8, updates to the DSS were reported in the quarterly technical progress reports rather than in stand-alone reports.

Development of a Demonstration Project Reporting System (DPRS)

Collection of information specific to the demonstration sites is an ongoing effort. It was originally intended to populate a Web-based interface to house the data and facilitate communication and interpretation of the data. A DPRS was created to provide structured access to data from the PCOR Partnership Phase III demonstration projects at Bell Creek and Fort Nelson. With the development of DOE's Energy Data eXchange (EDX)—which has a wider application and functionality, a larger user base, and long-term viability beyond the project—data are submitted to this workspace.

It should be noted that the requirements for DPRS updates (D10) in September 2014 and 2016 were deleted in September 2012. Data and information for field demonstration projects, upon receipt of approval from the commercial site owner/operator, are provided in PowerPoint presentations at meetings and conferences. In PY8, an effort to compile these public data and information with annotations for the PCOR Partnership members was initiated. This will be completed in PY9 and provided to the members.

Collaboration with Petroleum Technology Research Centre's (PTRC's) Aquistore Project

PTRC at the University of Regina is in the process of conducting a CCUS project in southeastern Saskatchewan, Canada, to demonstrate the feasibility of CO_2 storage in a deep saline formation. This CCUS project, formally known as Aquistore, is operated by SaskPower.

The PCOR Partnership is collaborating with PTRC and SaskPower, assisting in the site characterization, acting as advisor in the risk assessment and MVA activities, and directly performing aspects of the modeling and simulation activities. The PCOR Partnership will utilize site characterization data collected by PTRC and SaskPower to update the geologic model and perform predictive simulations. The period of performance for this subtask was July 2012 – June 2013, subsequently extended to March 31, 2014. Based upon positive feedback received from the

PTRC SERC (Science and Engineering Research Council), an extension to March 31, 2016, was requested and approval was granted by the DOE NETL project manager, along with a continuation of modeling and simulation efforts and completion of a new deliverable (D93, Update 2, due February 29, 2016).

The Aquistore project is part of the world's first commercial postcombustion CCUS project from a coal-fired power-generating facility, the SaskPower Boundary Dam, located in Saskatchewan, Canada, and will be acting as a storage site for a portion of the captured CO_2 from the Boundary Dam power plant. The Aquistore site includes one injection well and a 152-meter offset observation well. Both wells were drilled and completed in the Deadwood and Black Island Formations.

Intermittent CO_2 injection commenced in April 2015. Injection quantities were limited by capture plant operating conditions and CO_2 sales obligations. Approximately 8000 U.S. tons were injected before a late-summer shutdown of the capture plant for repairs/upgrades. Injection has recommenced intermittently as CO_2 is available from Boundary Dam. As of the end of PY8, CO_2 had not yet been observed at the observation well.

During injection, multiple production-logging, or spinner, surveys were performed in the injection well to help determine the flow distribution among the four perforation intervals in the well. In the observation well, several PNL runs were performed in anticipation of detecting the first arrival of CO_2 at the well.

Aquistore Geologic Modeling and Simulation Activities

Work continued on the geologic modeling and simulation activities following the submittal of D93 "Geologic Modeling and Simulation Report for the Aquistore Project (update 1)," which was submitted September 30, 2014, and approved November 6, 2014 (5).

Subsurface modeling has focused on history match efforts to replicate early injection and observation well behavior. Pressure response to injection was clearly seen in the observation well, and this response has been matched by the simulation, indicating good agreement among model porosity, injection fluid distribution, mass balance, and overall interwell permeability. Replication of near-wellbore performance of the injection well is more challenging. During the initial months of injection, an apparent level of formation damage in some intervals and stimulation in others was observed.

Aquistore Petrophysical Activities

One of the goals of the PCOR Partnership is to develop a first-order, reconnaissance-level estimate of the potential CO_2 storage resource of a wide variety of geologic formations in the region. To date, research efforts to better understand and estimate CO_2 storage capacity/resource have been largely focused on relatively permeable targets, such as saline formations and conventional oil reservoirs. However, as development of unconventional oil and gas reservoirs throughout North America continues to expand, there is increasing interest from stakeholders regarding the feasibility of CO_2 storage and/or simultaneous CO_2 storage and EOR within these types of formations. To determine the role that a tight oil formation, such as the Bakken, may play

in CCS, it is critical to understand its petrophysical characteristics that would make it amenable to CO_2 injection. In 2014, the EERC received samples from the upper and middle members of the Bakken Formation that were collected from the PTRC Aquistore Project CO_2 injection well in southern Saskatchewan, Canada. Laboratory activities were conducted, including petrographic analysis, capillary entry pressure determinations, total organic carbon analysis, porosity and permeability analyses, and mineralogical analyses.

In all, ten samples were collected and tested over the course of this evaluation: nine middle member samples and one upper shale sample. Test results indicate that the Middle Bakken in this area is composed of three unique members, labeled from bottom to top Units A, B, and C (as shown from thin section scans in Figure 4). This correlates well with existing published literature. The average porosity and bulk density of nine middle member samples were determined to be 6.75% and 2.54 g/cm^3, respectively. The relationship indicates a quartz sandstone-to-limestone-dominated system, which is confirmed through optical thin-section analysis. Mineralogically, the middle member was determined through x-ray diffraction, x-ray fluorescence, and scanning electron microscopy to be dominated by quartz, illite clay, and potassium feldspar. While the samples contain the minerals dolomite and calcite, they are in lower percentages than the rocks of the central Williston Basin. Total organic carbon was found to be less than 1 wt% in each middle member sample tested and about 15 wt% in the upper shale. The evaluation indicated that this area is not likely capable of economically producing oil because the quality of organic carbon was not considered mature.

Figure 4. Whole thin-section scan demonstrating textural differences throughout the three Middle Bakken units observed in this well. Units A, B, and C are shown from left to right.

Regarding the CO_2 storage potential, samples were evaluated to determine their effective porosity, pore throat distribution, and relative permeability to brine and CO_2. Results of the mercury injection capillary pressure work indicated that the shale and stratigraphically adjacent upper Unit C have a pore throat size distribution of less than 0.25 μm, typically of rocks considered "geologic seals," or good barriers to fluid flow. The middle unit (B) and lower unit (A), while still small in scale, have a wider size distribution of less than 7.5 μm that may aid in the injection and movement of fluids away from a wellbore during CO_2 storage.

Relative permeability tests were conducted on two samples from Unit B. Results indicate the potential to move CO_2 through core plugs saturated with 286,000 ppm brine. The relatively high porosity (13.9%), laminated, fine-grained sandstone had a permeability to brine of 1.17 mD, an irreducible brine saturation value of 44.1%, and a permeability to CO_2 of 1.17 mD. The sample with tighter-grained fabric (4.7% porosity) had a permeability to brine of 0.007 mD, an irreducible brine saturation of 58.6%, and a permeability to CO_2 of 0.003 mD. It was noted during testing that as the brine was mobilized and "pushed" out of the way, CO_2 flow became more efficient and pressure across the sample decreased. This is not a surprising result considering the large viscosity differences between the two fluids. However, this indicates that the formation may be amenable to use as a secondary CO_2 storage reservoir should the need arise. Further evaluation of this formation is needed regarding injection testing and modeling and simulation of the reservoir prior to making a complete determination. It is anticipated that this may be an area of focus for future evaluations (6).

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

The primary purpose of Atlas V was to update U.S.–Canada CO_2 storage potential and provide updated information on DOE's Carbon Storage Program and international CCS collaborations as well as on the activities of DOE's seven RCSPs. Atlas V includes a feature spread on each partnership's large-scale field project. In order to support Atlas V efforts, the PCOR Partnership participated in multiple conference calls to discuss the progress of data compilation and provided data via NATCARB (DOE NETL's distributed NATional CARBon Sequestration Database and Geographic Information System), including photos and text focused on the Bell Creek project. Atlas V was released by DOE on September 28, 2015.

DOE Carbon Storage Project BPMs

The PCOR Partnership is playing an active part in the revision/redevelopment of DOE Carbon Storage Project BPMs. The DOE BPM relevant to PCOR Partnership Task 1 activities is the Site Screening, Site Selection, and Initial Characterization for Storage of CO_2 in Deep Geologic Formations BPM previously revised in 2013. The following activities were performed in PY8. PCOR Partnership personnel participated in conference calls and Webinars with the working group tasked with updating this BPM. PCOR Partnership personnel worked on reviewing and commenting on the existing BPM and the proposed outline for the revision. An updated list of sidebars highlighting PCOR Partnership-specific experiences and comments on the report outline were provided to the working group for consideration.

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, PY8 (October 1, 2014 – September 30, 2015) are addressed as follows.

Meetings and Conferences

EERC employees attended 48 conferences/meetings and 12 workshop/seminars at the regional, national, and international level. As a result, numerous external individuals and groups were exposed to the PCOR Partnership name, messaging, and informational materials, and numerous participants within the RCSP Initiative were updated on PCOR Partnership activities. The meetings/conferences featured audiences ranging from the general public, to educators, to scientists and researchers, to regulators and partners. Specifically, the PCOR Partnership peer and public outreach activities included 48 oral and 13 poster presentations, 28 recycled posters, and four recycled and two new booths.

Outreach Material Distribution

The standard PCOR Partnership outreach packet contains some combination of the five documentary DVDs, the regional atlas, fact sheets, and other program materials. The materials are provided as part of presentations in select venues (e.g., teacher workshops), as part of acquainting new contacts with the PCOR Partnership Program, and by request through the PCOR Partnership public Web site or other pathways (e.g., telephone or e-mail). During PY7, the PCOR Partnership distributed nearly 1100 documentary DVDs and 370 atlases. During PY8, the PCOR Partnership distributed over 700 documentary DVDs and 318 atlases, as follows:

- PCOR Partnership documentary entitled "Nature in the Balance: CO_2 Sequestration" – 88
- PCOR Partnership documentary entitled "Reducing Our Carbon Footprint: The Role of Markets" – 89
- PCOR Partnership documentary entitled "Out of the Air: Into the Soil" – 85
- PCOR Partnership documentary entitled "Managing Carbon Dioxide: The Geologic Solution" – 272
- PCOR Partnership documentary entitled "Global Energy and Carbon: Tracking Our Footprint" – 221

- PCOR Partnership documentary entitled "Installing a Casing-Conveyed Permanent Downhole Monitoring System" – 4

- *PCOR Partnership Atlas, 4th Edition, Revised* – 318

Throughout the course of the program, the PCOR Partnership has distributed a total of 5753 copies of the various regional atlas editions and 10,054 copies of the five different documentary DVDs and the technical training video.

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 CO_2 storage in general and the PCOR Partnership specifically. The next version of the plan is scheduled for March 2016.

Data Acquisition and Management

The outreach data management system is envisioned as an addition to the DSS to consist of GIS-compatible databases. During PY8, this system was used to track outreach activities and product distribution and use for the Web site, PowerPoint presentations, fact sheets, and documentary products both at the regional level and for the areas of the demonstration projects.

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

Web Site Updates

The PCOR Partnership public Web site has been online since June 2004. This Web site will be updated and expanded as appropriate, with major updates on a biennial basis. Task 2 personnel began work on the D13 Public Web Site Update due July 31, 2016. The initial changes included both presentation and functional changes to the Web site. Presentation changes included an update to the Web site's home page, a new page dedicated to outreach posters, and a new technical publications section comprising existing technical content (reports and video) and new access to PCOR Partnership posters presented at technical meetings and conferences. Functional changes included improving Web site visitor tracking and search engine optimization activities. These and other updates are expected to be ready for review in PY9.

Web Site Activity Tracking

The PCOR Partnership has used Google Analytics (GA) to track activity for the PCOR Partnership public Web site since April 2010. During PY7, Google upgraded from "classic" analytics to Universal Analytics (UA), which is designed to move away from session-based tracking to user-based tracking across all devices (e.g. desktop, mobile, tablet), thus improving tracking analytical potential. To accompany this change, Task 2 personnel updated the standard operating procedure (SOP) for Web tracking, including guidance on naming PDF, video, and Web pages as well as assigning URLs, and provided a search engine optimization protocol for PDFs

(both in place and additions). In the wake of the transition from classic to UA, the PCOR Partnership is monitoring UA results closely in order to identify concrete examples of improved capability as well as potential issues.

The UA upgrade contains noticeable differences regarding the naming of two key metrics: 1) visits are now shown as sessions and 2) visitors are now referred to as users. Because of the renaming of these metrics, visits and visitors will be used along with sessions and users, respectively, in reporting.

As instituted in the beginning of PY6, the Advanced Segments feature in GA is used to exclude internal Web site traffic (project personnel and Web site maintenance visits), thus providing a reasonable starting point to gauge public activity. The results reported below are for public (external) traffic only.

Sessions/Visits

As shown in Figure 5, there were 24,589 sessions/visits to the public Web site in PY8, an increase of 143% over PY7 (10,102 sessions/visits). However, only 4500 of these visits interacted with more than one page. Approximately 26% of these visitors came to the site using a mobile device or tablet, an increase from 16% in PY7.

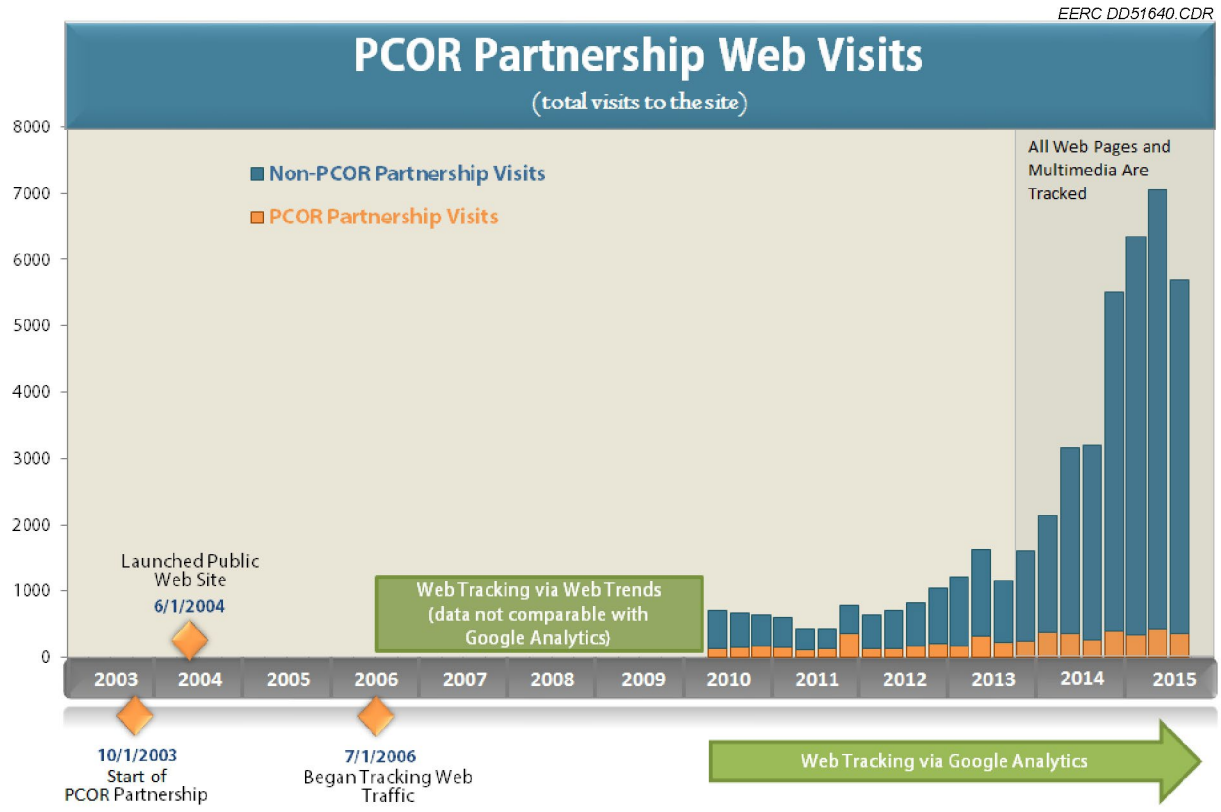


Figure 5. Cumulative bar graph of PCOR Partnership global Web traffic.

There were 21,144 unique visitors to the public Web site in PY8, representing a 146% increase from PY7 (8593 visitors). 84% of these visitors were new to the Web site during PY8.

The PCOR Partnership public Web site received traffic from 167 countries from October 1, 2014, to September 30, 2015, as illustrated in Figure 6. There were visits from 40 new countries. Of the 24,589 sessions/visits, 46% of the Web traffic was domestic and 54% was international. Table 3 lists the ten countries with the highest number of sessions/visits to the PCOR Partnership Web site. These included the United States, India, United Kingdom, Australia, Canada, Philippines, Malaysia, New Zealand, Pakistan, and Germany.

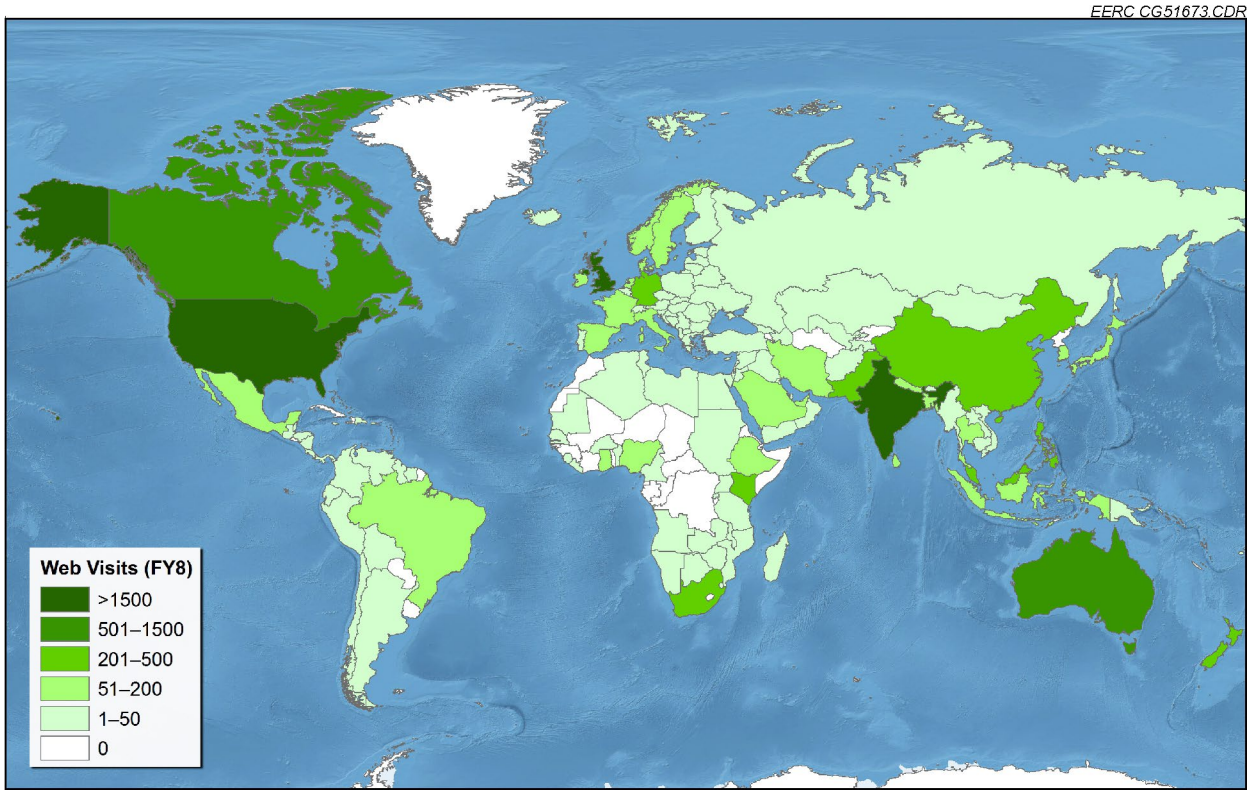


Figure 6. Map of PCOR Partnership global Web traffic for PY8.

There were 1631 sessions/visits from within the PCOR Partnership Region. Approximately 68% of regional visits originated from the United States and 32% from Canada. Figure 7 illustrates Web visits to states and provinces within the region.

Sessions/visits from the PCOR Partnership region represent 6% of the total traffic to the public Web site (It should be noted that the totals may overestimate regional traffic to some degree because the visit location data were aggregated at the state and province level even though the PCOR Partnership region formally includes only portions of British Columbia, Montana, and Wyoming).

Table 3. Visit Activity from the Top Ten Countries and the PCOR Partnership Region

	Country	Visits*	PCOR Partnership State/Province	Visits*
1.	United States	11,234		
			North Dakota	278
			Minnesota	235
			Wisconsin	150
			Missouri	146
			Iowa	79
			Montana	73
			Nebraska	60
			Wyoming	58
			South Dakota	34
2.	India	3368		
3.	United Kingdom	1634		
4.	Australia	1130		
5.	Canada	1040		
			Alberta	276
			British Columbia	145
			Saskatchewan	76
			Manitoba	21
6.	Philippines	420		
7.	Malaysia	347		
8.	New Zealand	295		
9.	Pakistan	258		
10.	Germany	247		
	Other 167 countries	4616		
	Total Visits	**24,589**	**Total PCOR Partnership Visits**	**1631**

*Arranged by the number of visits to the site.

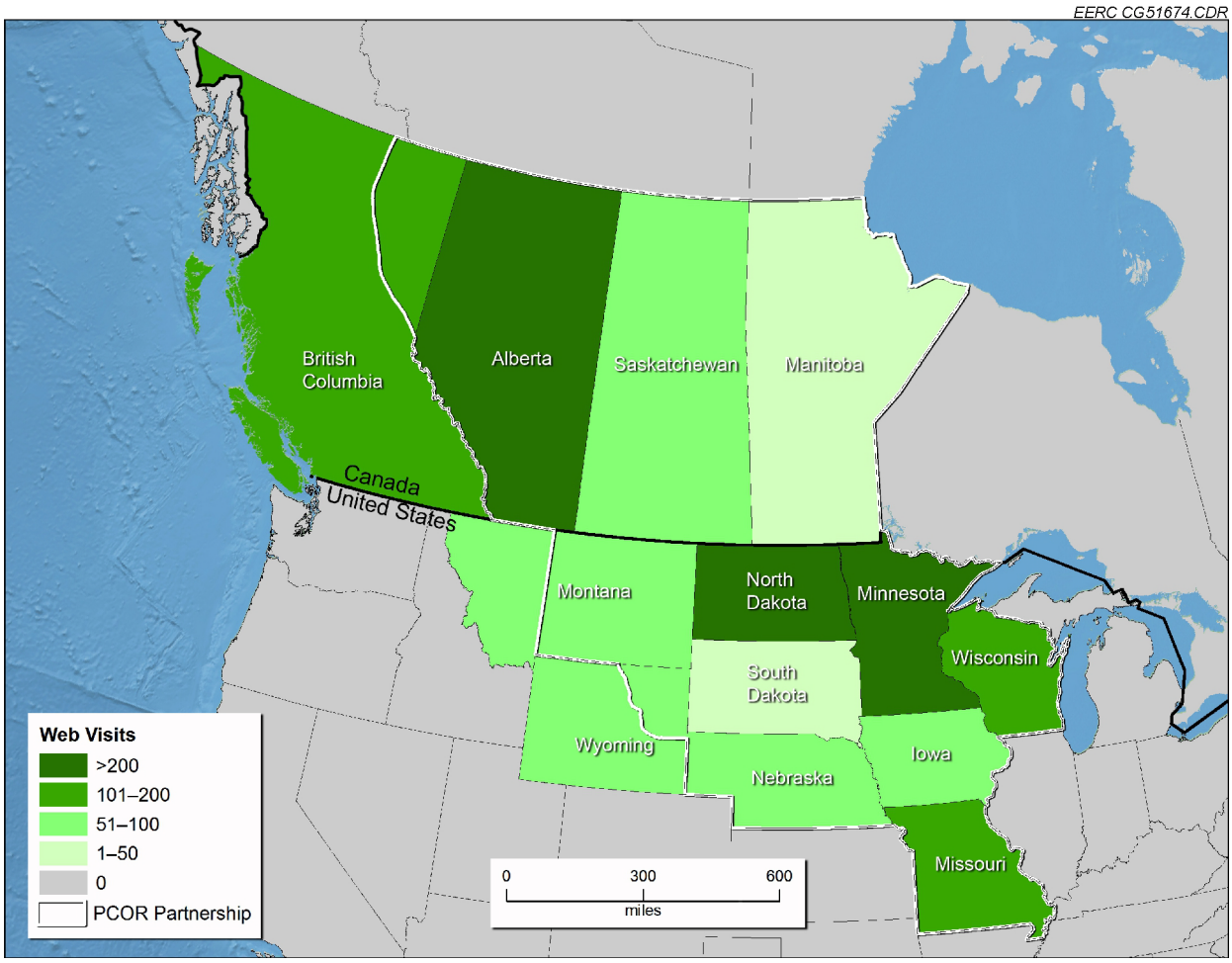


Figure 7. Map of PCOR Partnership regional Web site sessions/visits for PY8.

Traffic Sources

Traffic sources indicate how users/visitors came to the PCOR Partnership Web site. The three general categories of traffic sources include search, direct, and referral sites. Lesser traffic sources are acquired from social media and campaigns. These categories and their percentage of the total traffic sources are presented in Figure 8.

Search traffic refers to the use of search engines such as Google, Bing, and Yahoo. Search traffic accounted for more than 85% of the overall traffic that came to the public Web site. GA provides keywords visitors used to find the public Web site. The top three keywords and phrases used include "what is CO_2," "carbon sequestration," and "what is carbon sequestration."

Direct traffic consists of those users/visitors who bookmark or type a specific PCOR Partnership URL, e.g., www.undeerc.org/pcor, into a Web address bar. Direct traffic accounted for over 11% of the overall traffic.

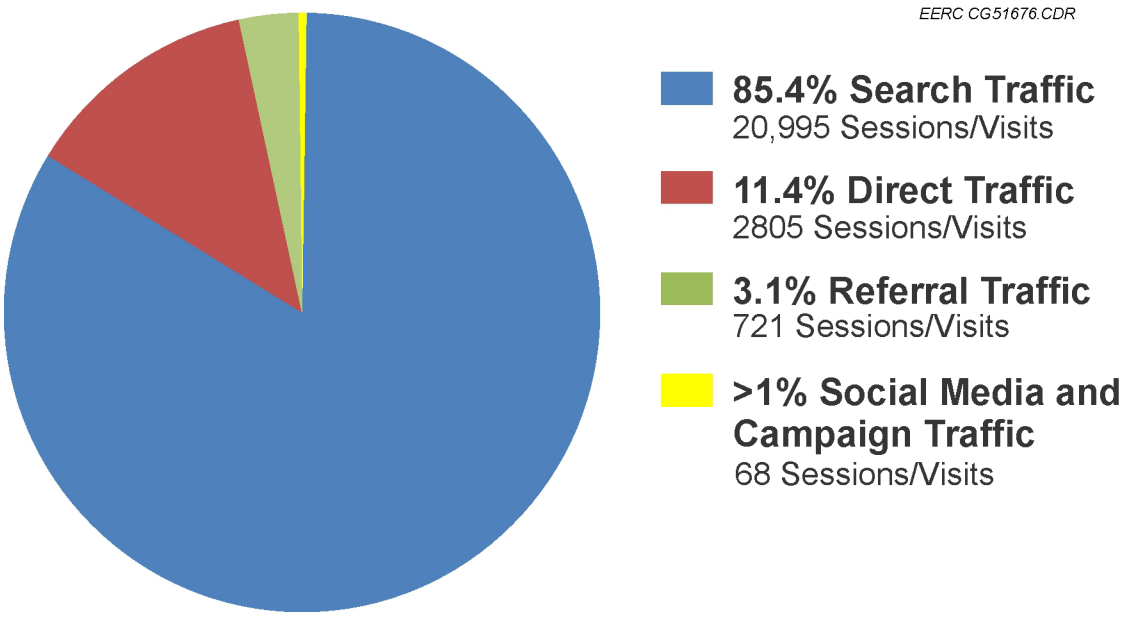


Figure 8. PCOR Partnership public Web site traffic in PY8.

Referral traffic is traffic to the PCOR Partnership Web site from other sites via links. About 3% of external traffic resulted from referral sites. The top three referring Web sites were those from energy.gov, globalccsinstitute.com, and energy.usgs.gov.

Less than 1% came from teacher campaigns and social interactions, such as e-mail, or from social media sources like Facebook or YouTube.

Nature of Sessions/Visits

A total of 34,394 page views (a 90% increase from PY7) resulted from the 24,589 sessions/visits to the PCOR Partnership public Web site in PY8. The top five viewed Web pages comprised about 74% of page views overall. The "What Is CO_2 Sequestration?" and "What Is CO_2?" pages accounted together for over 63% of the total page views (Table 4).

Table 4. Top Pages for "Page Views" on the PCOR Partnership Public Web Site

Page Title	Page Views	% Page Views	Page URL
What Is CO_2 Sequestration?	15,332	44.5%	www.undeerc.org/pcor/sequestration/whatissequestration.aspx
What Is CO_2?	6587	19.2%	www.undeerc.org/pcor/sequestration/whatisco2.aspx
Home Page	1546	4.5%	www.undeerc.org/pcor/default.aspx
CO_2 Sequestration Projects	1172	3.4%	www.undeerc.org/pcor/co2sequestrationprojects/default.aspx
Terrestrial Sinks	878	2.6%	www.undeerc.org/pcor/region/terrestrial

Fact Sheets

Fact sheets have been 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.

The November 2014 version of the NETL fact sheet "Plains CO_2 Reduction Partnership – Development-Phase Large-Scale Field Projects" was added to the public Web site (replacing the previous version, www.undeerc.org/pcor/NewsAndPubs/pdf/NT42592.pdf).

The four Phase II project fact sheets are being updated as value-added products. This update includes alterations to content and the use of an expanded four-page format that features a first page highlighting key results and fast facts; inside-facing pages providing detail on approach and findings as well as a project time line; and a back page with frequently asked questions (FAQs), information on the PCOR Partnership, and contact information. Updates for the lignite test and the huff 'n' puff test were near completion at the end of PY8, and updates for the terrestrial and Zama project fact sheets were under way. The full set of four Phase II fact sheet updates will be completed in PY9 and will be made available in hard copy and on the public Web site.

PowerPoint Presentations

PowerPoint presentations have been developed for Phase III general activities as well as for each of the demonstration projects and for targeted outreach to specific audiences (e.g., educators). In September 2012, DOE NETL approved that future updates to D18 (Bell Creek) and D19 (Fort Nelson) are no longer required as separate stand-alone presentations. Instead, we will continue to give a variety of presentations related to these projects and will report upon the presentations, including any updates, in the technology transfer section. As indicated above, 48 oral presentations were given in PY8, and the majority included information on the Bell Creek project and other PCOR Partnership activities.

The general Phase III information PowerPoint presentation (D17) was updated for general use in May 2015. This update included five new slides to provide illustrations for energy density, EOR, and geologic CO_2 storage and 15 slides with updated text, data, or images. This slide show serves as the basis for many of the general outreach presentations, including those given at teacher seminars.

Outreach Working Group

The RCSP Outreach Working Group (OWG), comprising representatives from each of the seven regional partnerships as well as ad hoc representatives from DOE, 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 BPM entitled "Public Outreach and Education

for Carbon Storage Projects" was released in December 2009. The BPM is currently undergoing revision by the OWG.

Examples of the PCOR Partnership's participation in the OWG during PY8 include the following:

- Participated in ten (October 27, November 14, and December 18, 2014, and January 22, February 19, March 26, April 23, May 21, June 18, and September 17, 2015) monthly OWG conference calls. The primary focus of the OWG conference calls in PY8 was review and preparation of the major revision to the DOE NETL outreach BPM due to be released in PY9. The PCOR Partnership's role during PY8 included a full review of the existing BPM, preparation of a draft table to provide basic information on the projects and outreach efforts among the different partnerships, and initiating a rewrite of the introductory sections for consideration by OWG.

- Participated in the preparation of a paper and presentation for GHGT-12 entitled "Digital Communications: Status and Potential Applications for CCUS Public Outreach" for the "Communication and Attitudes in CCS" session on October 9, 2014 (paper available at www.sciencedirect.com; citation for the paper is listed in the Phase III Products section, by author, under Conference Papers). Attended the conference.

Posters

In collaboration with Denbury, a Bell Creek test site poster (D25) entitled "CO_2 Emissions Go to Work to Produce More Oil" was originally approved in November 2011 for general audiences. Minor updates to the poster were made in PY8. The Bell Creek Story text box was updated to generalize any references to the CO_2 source and to add the sentence, "CO_2 injection began May 2013, and as of July 1, 2014, 1 million metric tons had been injected." The map inset was updated to reflect CO_2 source additions from the LaBarge Field. The text in Box 2 was adjusted to indicate the processing plants that are currently providing the CO_2. The text in Box 5 was adjusted to past tense. The updated Bell Creek test site poster was approved February 2015 (Figure 9). This revised poster was displayed at meetings, including the PCOR Partnership Annual Membership Meeting; was provided to Denbury for its use; is on display at the EERC; will be linked from the Bell Creek project page on the public Web site; and will be available in PY9 from the new public outreach poster Web page.

Figure 9. Bell Creek test site poster update (February 2015).

Documentaries and Video Products

A spectrum of video products is developed to meet the needs of general and site-level outreach. Broadcast-quality documentaries are produced in partnership with Prairie Public Broadcasting (PPB), are broadcast in the PPB market area, are made available to other public broadcasting markets for possible broadcast, are placed on the public Web site, and are available as DVDs. Video segments and products are intended for stand-alone use in meetings, in PowerPoint presentations, and on public Web pages.

Bell Creek Project-Related Filming

The Bell Creek (D21) demonstration site documentary is due April 2016, which is expected to be revised in the BP5 continuation application. Interviews with Denbury personnel and minor location filming remain to complete the production phase of the documentary. This work was deferred until adequate experience was gained at the site. As a result, no additional filming activities were conducted in PY7. However, a "teaser" video (approximately 1:25 minutes) outlining the proposed documentary was prepared to be presented to Denbury in October 2015 (PY9).

Coal in the Modern Age 60-minute Documentary Filming

A 60-minute documentary (D22) under development is due January 2016, which is expected to be revised in the BP5 continuation application. On January 11–12, 2015, PCOR Partnership personnel and a PPB film crew traveled to Houston, then Plano, Texas, for filming at Rice University and then North American Coal Corporation's headquarters, respectively. The filming included interviews with Chuck McConnell, professor at Rice University, and executives J.C. Butler and Carroll Dewing of North American Coal.

In March 2015, PCOR Partnership personnel and a PPB film crew completed 3.5 hours of location filming at the Lowell, Massachusetts, National Historic Park.

On May 31 – June 3, 2015, PCOR Partnership personnel and a PPB film crew completed interviews in New York City, New York, and Arlington, Virginia, and location filming in New Jersey and Pennsylvania. On June 8–12, 2015, interviews and location filming were completed in western Pennsylvania. Interviews included Mark Brownstein, Environmental Defense Fund; Ned Leonard, ScofieldEdwards, LLC; Charles Patrick, Penn State Fayette; Elaine DeFrank, Penn State Coal and Coke Heritage Center; and Ron Baraff, Rivers of Steel National Heritage Area. Location footage comprised 7.5 hours of historically significant energy and industrial revolution sites, e.g., the Kingston, New Jersey, canal system; Ranking, Pennsylvania, Carrie Furnace; Rice Landing, Pennsylvania, machine shop; Dunbar coke oven; Ashland, Pennsylvania, Pioneer Tunnel; and Harwick, Pennsylvania, Coal Miners' Memorial.

On June 22–25, 2015, PCOR Partnership personnel and a PPB film crew traveled to Meridian, Mississippi, to complete interviews and location filming at the Kemper County Energy Facility in DeKalb, Mississippi, and the nearby Liberty Mine. Interviews included Bruce Harrington, Mississippi Power, and Vern Lund, Liberty Fuels. Ninety-seven minutes of location footage was obtained, including shots in and around the Kemper County Energy Facility as well as the coal mine.

On June 29 – July 1, 2015, PCOR Partnership personnel and a PPB film crew traveled to White Salmon, Washington, for an interview with Michelle Nijhuis, freelance journalist with *National Geographic*.

On September 15, 2015, PCOR Partnership personnel and a PPB film crew interviewed author, *New York Times* columnist, and Boing Boing Science Editor Maggie Koerth-Baker in Minneapolis, Minnesota.

Interviews and location filming will continue into PY9. Permission was obtained for an interview and location filming at the Dakota Gasification Company facility in North Dakota and the adjacent Freedom Mine for use in the D22 documentary.

Plans are under way to extend the due date of D22 and for an additional international trip, most likely to India or to China, in spring 2016. Discussions have been held with personnel from the World Resources Institute and with The Global Carbon Capture and Storage Institute with respect to aid in scheduling, designating interviews, identifying locations, and travel arrangements.

Aquistore Project-Related Filming

During PY8, Task 2 personnel provided Aquistore with a list of interviews and location shots available from past filming by PPB for consideration for future use in its outreach activities. Aquistore personnel were also provided with a sampler of video clips as a basis for determining clips of interest for final production.

PCOR Partnership personnel and a PPB film crew traveled to Estevan, Saskatchewan, Canada, to attend and film the Aquistore ribbon-cutting ceremony held on May 29, 2015. Approximately 67 minutes of footage was shot during the ceremony and subsequent site tour. The footage included signage, injection equipment, monitoring equipment, and select remarks by speakers.

Educator-Related Video Production

In PY8, production continued on a four-part Carbon and Energy video series for use by educators. This video series features a combination of multimedia, including PowerPoint presentations, filmed excerpts, and narration. Parts 1 and 2 were approved by management at the EERC, and Parts 3 and 4 will be completed in PY9. Video Education Series Part 1 entitled "Energy" was finalized and uploaded to Prairie Public Services Learning Media in PY7. It is available at http://prairiepublic.pbslearningmedia.org/resource/372e3e5a-423f-4071-8d33-c1f80b2e2e6b/pcor-eerc-dan-daly-presentation-part-1/. Video Education Series Part 2 entitled "Carbon and Energy" was finalized and uploaded to Prairie Public Services Learning Media on June 22, 2015. It is available at http://prairiepublic.pbslearningmedia.org/resource/3c031e45-dbcb-4dc3-9037-71982dc69346/dan-daly-presentation-part-2-energy-pcor-eerc/.

YouTube Exposure

In an effort to expand the PCOR Partnership outreach initiative, 50 video clips and five full-length documentaries (currently available on the public Web site) were uploaded to the EERC's YouTube channel on April 1, 2014 (www.youtube.com/user/undeerc/videos?sort=dd&shelf_id=1&view=0). Table 5 provides a summary of the top five viewed video items over PY8. Two PCOR Partnership full-length documentaries are also on the PPB YouTube Channel. The activity on the PPB site for PY8 is shown on Table 6.

Table 5. Top Five PCOR Partnership-Related YouTube Channel Videos Accessed

Video	Video Length, minutes	Views	Est. Minutes Watched
Reducing Our Carbon Footprint: The Role of Markets	26:49	16,328	2745
Reforestation in Brazil	4:41	3382	1547
The Phases of Oil Recovery – So Far	2:40	1486	780
Household Energy Around the World	5:34	1183	333
Installing a Casing-Conveyed Permanent Downhole Monitoring System	1:50	1073	239

Table 6. PCOR Partnership Documentaries Accessed on the PPB YouTube Channel

Video	Video Length, minutes	Views	Watch Time, minutes	Avg. View Duration
Global Energy and Carbon: Tracking Our Footprint	32:36	6210	50,797	13:03
Managing Carbon Dioxide: The Geologic Solution	31:40	806	9333	11:58

Broadcast of Documentaries

In PY8, the PCOR Partnership received television exposure from documentaries which were broadcast on public television stations in four states and one Canadian province. A total of 57 broadcasts were aired, which is similar in number to the 50 broadcasts in PY7 (however, it is significantly higher than in PY6 [18] and lower than in PY5 [66] and PY4 [221]). The number of telecasts by documentary is as follows: "Out of the Air: Into the Soil" (15), Managing Carbon Dioxide: The Geological Solution (24), and "Global Energy and Carbon: Tracking Our Footprint" (18). All three documentaries were aired in the PCOR Partnership region.

Public Outreach Presentations

In PY8, the PCOR Partnership participated in three teacher training workshops and education conferences as well as university-level student and faculty presentations. These activities included introducing PCOR Partnership materials (DVDs, atlas, Web site awareness) to educators in K–12 schools. They included:

- A talk entitled "Energy and Quality of Life – Drilling Down" presented at UND's Harold Hamm School of Geology and Geological Engineering Annual Spring Banquet on April 17, 2015, in Grand Forks, North Dakota, attended by approximately 30 faculty and students.

- A 2-day science teacher conference presented by the North Dakota Science Teachers Association (materials disseminated) held March 20–21, 2015, in Bismarck, North Dakota.

- A 4-day coal-focused workshop presented by the North Dakota Lignite Energy Council (LEC) (presentation given, materials disseminated) held June 16–19, 2015, in Bismarck, North Dakota.

- A 2-day CCUS-focused teacher training institute (presentation given, materials disseminated) held June 23–25, 2015, in Moorhead, Minnesota.

The educator workshop presentations reached a total of 183 teachers representing 118 different school districts in five states in the PCOR Partnership region. Compared to PY7, there were more teachers reached (168 teachers) and more school districts (81 districts). Twenty-three of the PY8 teachers (13%) had previously heard a PCOR Partnership outreach presentation at a different workshop. Figure 10 shows the geographic distribution of school districts having teachers who received materials.

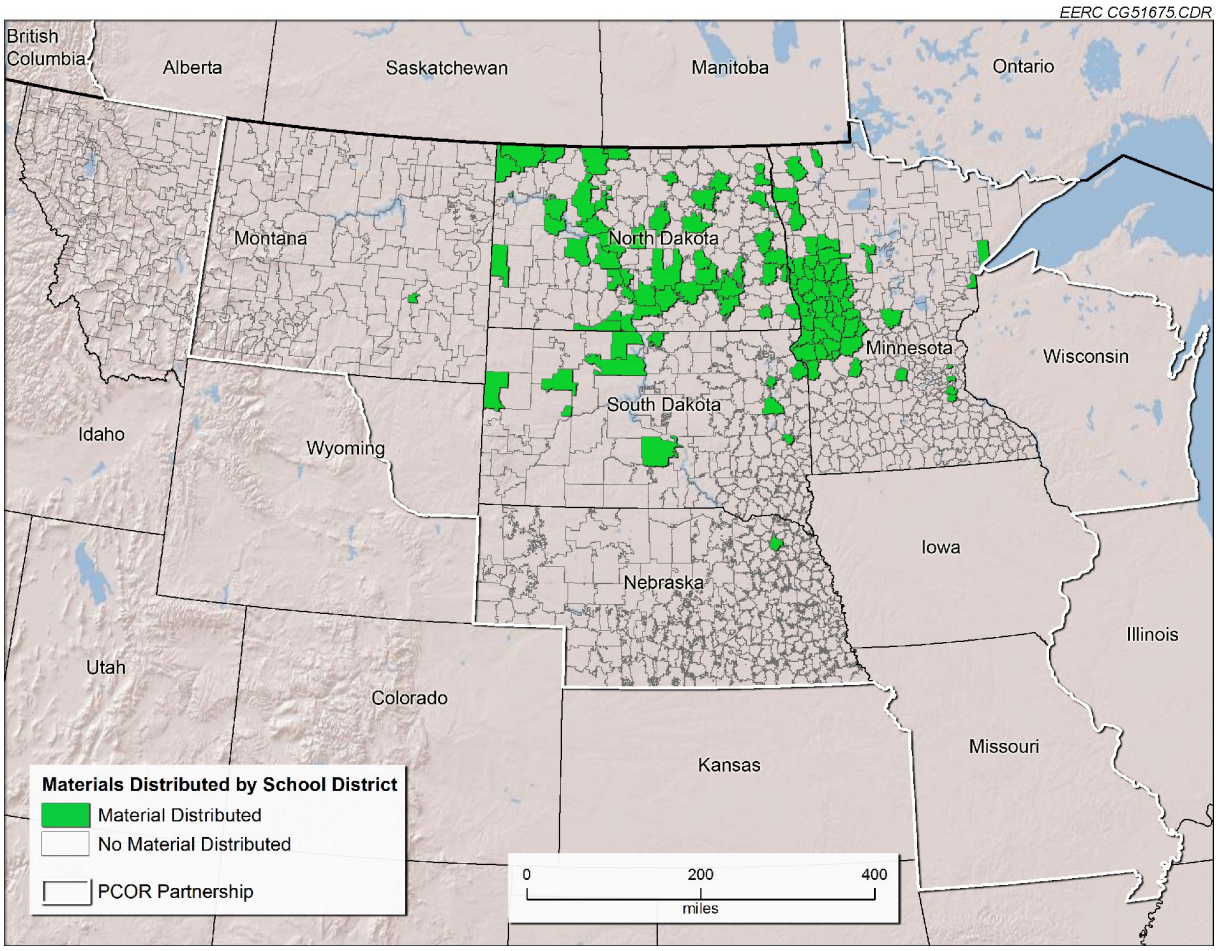


Figure 10. Distribution by school district of teachers who received outreach materials in PY8.

The LEC workshop and the presentation to the audience at the university event involved the use of audience feedback systems or "clickers" that allowed individual real-time response by members of the audience. The use of "clickers" enhanced audience engagement, allowed the

presenter to gauge the quality of information transfer and audience knowledge, and resulted in feedback that can be used to improve future presentations.

Project-Related Outreach Activities

There were four near-surface assurance-monitoring events at Bell Creek during PY8. Outreach for these events included periodic telephone and personal contact with the eight landowners controlling access to water wells and ponds slated for sampling. Follow-up to these events included verbal contact as well as written reports of sampling results provided to each of these landowners.

Task 2 personnel represent the PCOR Partnership on the Aquistore Outreach and Advisory Working Group led by PTRC. During PY8 participation included the following:

- Participated in conference calls and e-mail correspondence. Topics discussed included updates on technical activities and project milestones; visitors to the site; and activities, arrangements, and the press release for the Aquistore ribbon-cutting event, which occurred May 29, 2015.

- PCOR Partnership personnel accepted an invitation to attend and participate in the Aquistore Open House held December 11, 2014, at the Energy Training Institute in Estevan, Saskatchewan. Upon request, Task 2 personnel provided review comments on draft display materials as well as copies of the general CCUS outreach poster (D24) and the Aquistore Project poster (D95), both of which were displayed at the open house.

Media Coverage

Media coverage is defined as articles related to the PCOR Partnership on television or radio networks or in newspapers and magazines, including both print and online news sources. The EERC tracks media coverage internationally utilizing a variety of clipping and news-gathering services. In addition, Google Alerts is used, which e-mails PCOR Partnership-related news retrieved from the Internet.

During PY8, two instances of coverage that included the PCOR Partnership were reported in newspaper articles as shown in Table 7.

Table 7. PCOR Partnership Media Coverage

Date	Headline	Media Organization/ Publication	City	Journalist, Author, or Source	Type
2/12/2015	PCOR: The Partnership to Reduce Carbon Dioxide	Beulah Beacon	Beulah, North Dakota	Chris Erickson	Print Newspaper Article
4/29/2015	PPB offering two-day teacher training institute	Jamestown Sun	Jamestown, North Dakota	Staff report	Print newspaper article

Additional Conference/Meeting Participation

- Attended the 2015 National Energy Education Summit (www.ncseonline.org/2015-national-energy-education-summit) and the Energy and Climate Change 15th National Conference and Global Forum on Science, Policy, and the Environment (www.energyandclimatechange.org/) in Washington, D.C.

- Attended the 10th Annual Southeast Regional Carbon Sequestration Partnership (SECARB) Stakeholders' Meeting March 11–12, 2015, in Atlanta, Georgia.

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. Effective November 25, 2014, Charles Gorecki assumed the task leader responsibilities.

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, PY8 (October 1, 2014 – September 30, 2015) are detailed as follows.

General Permitting Assistance

The EERC interfaces 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. The EERC determines anticipated permitting activities for potential projects in all states and provinces of the PCOR Partnership region. The information gathered through these efforts as well as lessons learned during Regulatory Roundup Meetings will be summarized in D76 "Regional Regulatory Perspective" due August 2017.

A value-added report was initiated to gather information on rules, regulations, and statutes for various scenarios of CCS geologic storage and for CO_2 EOR for each of the PCOR Partnership states and provinces.

D8, Permitting Review – Update 2

On September 30, 2015, an update to the 2013 permitting review was submitted. This document provides a brief update on the requirements to conduct a geologic CO_2 storage project in the United States or Canada. Not a lot has changed in the United States in the past 2 years since the first permitting review was submitted in September 2013 (7). The information provided herein gives a broad overview of the regulatory requirements and the authorities involved. As of this writing, EPA has the authority to permit CO_2 geologic storage wells in all 50 states. Additionally, EPA requires geologic storage projects to comply with the Mandatory Reporting of Greenhouse Gases Rule (MRR) (8). In Canada, the provinces have the authority to permit geologic storage projects.

U.S. Environmental Protection Agency

In December 2010, EPA finalized the requirements for a new well class (Class VI) under the authority of the Safe Drinking Water Act's (SDWA's) Underground Injection Control (UIC) Program. The rule established federal requirements for the underground injection of CO_2 for the purpose of long-term underground storage, or geologic storage. As of September 7, 2011, EPA directly implemented the Class VI program nationally. As a result, in order to permit a CO_2 geologic storage project, potential owners or operators of a CO_2 geologic storage well will need to submit a permit application to the appropriate EPA regional office.

On June 21, 2013, the North Dakota Industrial Commission (NDIC) Department of Mineral Resources Oil and Gas Division (North Dakota) submitted its primacy application. On October 29, 2013, the NDIC Department of Mineral Resources Oil and Gas Division (North Dakota) finalized the memorandum of agreement (MOA) with EPA Region 8. The MOA was signed by Lynn Helms, Director of the Department of Mineral Resources, on November 24, 2013, and by EPA's Region 8 Administrator Shaun McGrath on November 29. 2013. It was anticipated to take at least 6 months before North Dakota would know whether or not its application was approved by EPA. As of this writing, the application still awaits approval.

EPA's Class VI well has created many questions among state regulators and EOR operators. To address these concerns, Director of the Office of Ground Water and Drinking Water Peter C. Grevatt sent a memo on April 23, 2015, entitled "Key Principles in EPA's Underground Injection Control Program Class VI Rule Related to Transition of Class II Enhanced Oil or Gas Recovery Wells to Class VI" to the regional water division directors in an effort to clarify the transition of Class II wells to Class VI wells (www.epa.gov/sites/production/files/2015-07/documents/class2 eorclass6memo_1.pdf).

While this memo has helped to clarify some of the uncertainty in the EPA guidelines, it is the opinion of many EOR operators that several areas of uncertainty still have not been addressed. Some of the clarifications that need to be addressed include the regulatory uncertainty created by the potential of a forced transition from Class II UIC to Class VI UIC and the legal and regulatory uncertainty as to impacts on existing state mineral law, state rights, pore space ownership, private property rights, mineral rights, and existing and future unitization agreements.

On August 8, 2015, the Obama Administration announced the Clean Power Plan, which requires states to reduce carbon emissions from power plants. To meet these carbon pollution standards, EPA's Final Carbon Pollution Standards for New, Modified and Reconstructed Power Plants Rule (released August 3, 2015) could rely heavily on CO_2 EOR and CCS as part of a system of emission reduction (see pages 18 and 19 of www.epa.gov/airquality/cpp/cps-final-rule.pdf, accessed August 2015) (9).

In PY8, the following additional U.S. and Canadian regulatory-related items were reviewed:

- EPA Class VI guidance documents.

- DOE FutureGen 2.0 Project Class VI permit applications.

- Code of Federal Regulations sections:
  - Part 144 Underground Injection Control Program – provides minimum requirements for the UIC program promulgated under the SDWA.
  - Part 145S State UIC Program Requirements – outlines the procedures for EPA to approve, revise, and withdraw UIC programs that have been delegated to the states.
  - Part 146 Underground Injection Control Program: Criteria and Standards – includes technical standards for various classes of injection wells.
  - Part 147 State Underground Injection Control Programs – outlines the applicable UIC programs for each state.
  - Part 148 Hazardous Waste Injection Restrictions – describes the requirements for Class I hazardous waste injection wells.

- Alberta Energy Regulator, Canada, Directives on Energy Development (www.aer.ca/rules-and-regulations/directives), including:
  - Directive 051: Injection and Disposal Wells – Well Classifications, Completions, Logging, and Testing Requirements
  - Directive 065: Resources Applications for Oil and Gas Reservoirs

- Permitting process for PCOR Partner states and provinces.

Seventh 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 in 2010, 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 continuing goal of the meetings in 2011–2015 was to continue to develop strategies to work past state/provincial boundaries.

Nine people attended the 2015 meeting held July 22–23, 2015, in Deadwood, South Dakota, including a regulator from North Dakota and four representatives from the EERC. Also present were representatives of BillyJack Consulting, Inc.; Melzer Consulting; and The CETER Group.

Presentations were given on the following topics:

- PCOR Partnership Project Updates
- Canadian Update
- 2015 CCS Conference Overview
- Status of North Dakota Class VI Primacy and North Dakota Oil and Gas Industry Update
- The CCS Cost Gap – Ideas and Options for Bridging the Gaps
- IOGCC Annual Meeting, Salt Lake City, Utah
- Permitting for CCS in the PCOR Partnership

Interstate Oil and Gas Compact Commission

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 PCOR Partnership participates in IOGCC activities. In fact, John Harju is a past chair of IOGCC's Energy Resources, Research, and Technology Committee.

EERC staff members participated in the following IOGCC meetings in PY8:

- Attended the IOGCC Annual Conference held October 19–21, 2014, in Columbus, Ohio.

- Attended the IOGCC Annual Business Meeting held May 18–20, 2015, in Salt Lake City, Utah. Facilitated the IOGCC Environmental and Safety Committee meeting.

- Attended the IOGCC Annual Conference held September 28–30, 2015, in Oklahoma City, Oklahoma. EERC staff provided comments to NDIC on the IOGCC resolution and action plan "Clarifying Issues Related to Transitioning a Class II Carbon Dioxide Enhanced Oil or Gas Recovery Project to a Class VI Geologic Storage Project" for its submittal at the meeting.

Additional Conference/Meeting Participation

- Attended GHGT-12 in Austin, Texas, and the paper entitled "Guidance for States and Provinces on Operational and Postoperational Liability in the Regulation of Carbon Geologic Storage" was presented (paper available at www.sciencedirect.com; citation for the paper is listed in the Phase III Products section, by author, under Conference Papers).

- Attended the 2015 UIC Conference held in Austin, Texas, February 9–11, 2015.

- Attended the University of Wyoming's Enhanced Oil Recovery Institute's 9th Annual CO_2 EOR Conference and workshops in Casper, Wyoming, July 14–16, 2015.

Task 4 – Site Characterization and Modeling

This task involves selecting the two field-based large-scale demonstration sites and developing baseline characterization data and petrophysical models for such sites. The Bell Creek demonstration site work is continuing, but the Fort Nelson demonstration site work under Task 4 has been completed.

Activities and Results

Accomplishments during BP4, PY8 (October 1, 2014 – September 30, 2015) are described as follows.

Fort Nelson Demonstration Site

The primary objective of the Fort Nelson project was to verify and validate the concept of utilizing one of North America's numerous saline formations for large-scale CO_2 injection, proposed to be up to 2 million metric tons a year of anthropogenic CO_2 for permanent storage. In September 2014, this subtask was completed.

Bell Creek Demonstration Site

The Bell Creek oil field in southeastern Montana has been identified as a PCOR Partnership Phase III demonstration site. Detailed subsurface mapping and characterization are being conducted in advance of a large-scale study of CO_2 storage associated with CO_2 injection for EOR. Site characterization activities will be conducted to develop predictive models that address three critical issues to determine the ultimate effectiveness of the target formation: 1) the capacity of the target formation, in this case, an oil reservoir within an established oil field; 2) the mobility and fate of the CO_2 at near-, intermediate-, and long-term time frames; and 3) the potential for out-of-zone migration of the injected CO_2 outside of the field or into overlying formations and/or the surface environment. Key site characterization parameters that are being addressed include properties of the reservoir and seal rocks, properties of the fluids in the reservoir and overlying fluid-bearing formations, and the production and operational history of the target oil reservoir.

Bell Creek Test Site Baseline Geology Determination

The field data previously obtained through 3-D seismic acquisition, 3-D VSP survey, and PNL campaigns were utilized in geologic models. These data and models are used in conjunction with Task 9 – Operational Monitoring and Modeling data and models. The Task 4 activities were included in the August 2015 update to D66 (Bell Creek Test Site – Simulation Report). The updated report remains under review by Denbury and has not yet been finalized.

With the goal of providing a comprehensive assessment of associated CO_2 storage behavior, the PCOR Partnership has initiated a modeling and numerical simulation effort as part of its adaptive management approach to CO_2 storage program development. The modeling and simulation efforts include 1) characterizing and modeling the study area; 2) developing a robust pressure, volume, and temperature (PVT) model to predict the miscibility behavior of the system

and to aid in compositional simulation; 3) history-matching the constructed dynamic reservoir models; and 4) running predictive simulations to aid in monitoring long-term behavior of injected CO_2.

The update to D66 encompasses the modeling and simulation work completed since August 2014 and includes 1) the construction of a Bell Creek reference model to enable consistency across the various geologic modeling efforts, 2) the incorporation of 33 baseline and 19 repeat PNLs to improve the static and dynamic geocellular models, 3) history-matching and predictive simulations of the combined Phase 1 and 2 area (clipped from the Version [V] 2 geologic model), and 4) construction of a V3 geologic model, developed to incorporate 3-D surface seismic data and portray a new understanding of the reservoir's depositional history.

The reference model has been constructed to house key data sets associated with the Bell Creek Field, including 751 wells, field and processed logs, core analyses, structural tops, cultural surface boundaries, completed simulation results, ground surface elevation from lidar, and 3-D surface seismic data. The reference model will be important for future Bell Creek efforts to provide a foundation to ensure consistency across various modeling efforts.

Individual Phase 1 and 2 simulation models, previously developed and reported in Liu and others (10), have been combined to form a new simulation model that enables simulated fluid flow between the phases. It should be noted that the previously developed V1 and V2 geologic models (and, subsequently, the simulation results) have roots in the conventional Bell Creek depositional interpretation of stacked barrier bar sands within a large, Galveston Island-style depositional environment oriented approximately northeast to southwest. Recent investigations discussed within D66 (history-matching during simulation efforts, incorporation and interpretation of 3-D and 4-D seismic surveys, and comparison of PNL measured oil saturations with modeled oil saturations) have indicated this interpretation should be reexamined in renewed (V3) modeling efforts.

Integration and interpretation of the Bell Creek 3-D baseline surface seismic data lend support to a new depositional model with an interpreted local, transgressive barrier bar (as seen to be related to character in the upper Bell Creek sand interval) in Phases 1 and 2, indicating a large shift in inferred shoreline orientation from previous studies (approximately northwest to southeast). As such, a V3 model is under construction which will incorporate the new geophysical data, results from the history-matched simulation model, and the new geological interpretation. This model will then be used along with the V2 model in the history-matching and predictive simulation efforts to better understand the long-term fate of the injected CO_2 (11). EERC personnel traveled to Denver, Colorado, to view cores at the U.S. Geological Survey (USGS) Core Research Center (CRC-Denver) August 9–12, 2015. Information gained from viewing the core will help the interpretation efforts and provide an understanding of the Bell Creek depositional model.

Best Practices Manual – Site Characterization

The BPM for characterizing oil fields for CO_2 storage (D35) has been extended to October 31, 2016, to include enhanced site characterization as approved on September 25, 2015.

Work continued in PY8 on preparing the BPM with the current knowledge. Suggestions made by the TAB were discussed.

Petrophysical Evaluations for the Bell Creek Test Site

Full-diameter core was collected from 05-06 OW starting on December 21, 2011. Standard core analysis and special core analysis (SCAL) are being performed and utilized to supplement and update modeling efforts.

In March 2013, the EERC provided on-site technical advice during the collection of horizontal sidewall cores at the 56-14R well. In April 2013, the EERC provided on-site technical advice during the collection of full-diameter core at the 33-14R well. Petrophysical activities were performed for both sets of core in PY7 and completed in PY8 to supplement and update modeling efforts. The assessments included permeability-to-air and permeability-to-water measurements, fine-tuning of thin-section descriptions and x-ray diffraction data, and size and shape analysis data.

Core photo logs were developed to help determine core depth shifts, particularly for older core, in the geologic reference model. Pore-size and grain-size distributions were determined for Bell Creek USGS wells. Lab and modeling personnel worked together on facies interpretations for the USGS cored wells.

CO_2 Exposure Studies

The EERC conducted complementary laboratory studies to investigate potential CO_2–rock interactions. Exposure studies simulated CO_2 exposure to two zones of underground sources of drinking water overlying the Bell Creek oil and gas reservoir: the Hell Creek and Fox Hills Formations.

The Hell Creek effort provided geochemical and mineralogical data sets to develop an understanding of mineral dissolution/precipitation trends as well as groundwater chemistry changes as a result of interaction of CO_2 with the groundwater and formation rock. Groundwater samples were collected during the June 2012 sampling event. Drill cuttings from the 05-06 OW observation well and groundwater samples collected from wells drilled at depths approximately corresponding to the drill cuttings were utilized for testing. Three distinct groundwater locations along with six different drill cutting samples collected at depths ranging from 120 to 520 feet below ground surface were subjected to continuous CO_2 exposure at 25°C and 200 psig for a 30-day period. The results of the batch experiment testing provided information and semiquantitative data on potential mineralogical dissolution and/or precipitation reactions in the formation rock following exposure to CO_2.

The second experiments, focused on the deeper Fox Hills Formation, were conducted in 2013 and included testing to evaluate groundwater chemistry changes resulting from exposure to differing levels of CO_2 exposure at relevant temperature and pressure. Fox Hills Formation drill cuttings were collected during the installation of MW3312, and Fox Hills groundwater was collected from MW3312 after the well had been fully developed. PHREEQC model simulations predicted that groundwater chemistry changes (pH and TDS [total dissolved solids]) occur at a

very low concentration of CO_2 exposure. A central composite factorial test matrix was developed to establish batch laboratory testing conditions over a range of CO_2 concentrations (2.5% to 30%) and exposure times (7 to 21 days). Statistical analysis of batch test data showed good model fits for field-measured parameters (pH and alkalinity).

Test procedures and detailed test results were compiled in a value-added report in PY7. The report continues to be under review by Denbury.

Geomechanical Rock Properties and Stress Regime Determination

Site characterization activities for the Bell Creek Field are currently under way, including 1-D and 3-D geomechanical modeling. The comprehensive scope of this work includes building multidimensional, static geomechanical models as well as performing dynamic simulations using site-specific data. Information gained from this work can be used to assess various potential injection schemes, guide strategies for the MVA of the injected CO_2, predict geomechanical changes to the reservoir as a result of injection activities, better understand performance of the reservoir for both production and storage, predict potential risk scenarios, and provide insight into the ultimate fate of injected CO_2.

A 1-D mechanical earth model (MEM) was constructed based on existing data as well as field and laboratory data from a monitoring well (05-06 OW) drilled in December 2011. Stress regime and formation rock mechanical properties are in the 1-D MEM through the analyses on the existing data. Preliminary analyses using the 1-D MEM include estimation of predrilling wellbore stability and stress polygons for determining the faulting regimes within the reservoir. Then the 1-D MEM was updated with synthetic sonic logs and density logs from wells with appropriate logs throughout the whole field.

A 3-D MEM, which incorporates the entire Bell Creek Field, has been constructed with additional synthetic well logs and 3-D seismic data. Synthetic well logs using neutral network technique in Techlog were constructed in selected wells from every phase of the field. 3-D seismic data have been processed with time-depth conversion, depth shifting, and inversion. Several additional formation tops were picked for the formations below the reservoir to include the surrounding rock deep and far enough to avoid influence of boundary conditions on modeling and simulation results. A proper modeling area was selected to cover the field, and a 3-D geomechanical grid was built with the constructed mechanical stratigraphy. Finally, the 3-D rock mechanical properties have been populated into the whole modeling area through the genetic inversion process of the 3-D seismic volume attributes.

Following the completion of the 3-D MEM, a comprehensive geomechanical analysis will be performed to identify, anticipate, and evaluate predrilling wellbore stability, caprock integrity, the potential for induced fracturing of faulting, and the potential risk for out-of-zone fluid migration. It could also be used to match, monitor, and predict the geomechanical response from the reservoir, overlying formations, and surface. Additionally, predictive geomechanical simulations will be designed and performed that will help guide and update the MVA plan, evaluate potential risk scenarios, and ensure injected CO_2 remains stored within the reservoir.

Key results of this work include the following (including the previous D32 report [12]).

Horizontal Stresses – Caliper logs helped to determine the orientations of horizontal stresses in the region immediately surrounding the monitoring well. The orientations of the maximum and minimum horizontal stresses are north–northeast–south–southwest and northwest–north–southeast–south, respectively. It should be noted that the magnitudes of these stresses in the region surrounding the well are nearly equal. This is further supported by only slight wellbore deformations that were observed (the greater the difference in magnitude between these stresses, the higher the probability for large wellbore deformation and breakouts).

Wellbore Stability Analysis – Based on the current 1-D MEM, created based on data collected from the monitoring well drilled in December 2011, safe and stable mud weight windows were determined. No wellbore breakout will happen within the stable mud weight window, and this is corroborated by the fact that no breakouts have been found in the reservoir to date.

Induced Faulting – Preliminary stress polygon computations indicate that potential breakout through the reservoir as a result of drilling is extremely low.

Natural Fractures – 3-D seismic data were used to identify the natural fractures in the formations of the Bell Creek Field. Some natural fractures have been found in the formation above the reservoir but are not expected to be an issue since they are separated from the reservoir with more than 1000 feet of unfractured tight shales.

Synthetic Logs – To overcome the limitations from available data, bulk density logs and sonic logs were synthesized through the neutral network function in K.mod of Techlog. These synthetic logs are necessary data for building up 1-D MEMs for the wells in the field and further for the extension of the properties of the 3-D MEM.

3-D Seismic Data Time to Depth Conversion – 3-D seismic volume values were converted from time domain to depth domain using geophysical software from Hampson–Russell based on the velocity model and the tied depth horizon of the Bell Creek Formation.

3-D MEM Mechanical Properties – 3-D mechanical properties were populated into the area of the 3-D seismic data with the volume attributes and genetic inversion process. Using the synthetic logs from wells across the whole field, the 3-D MEM mechanical properties were then populated into the whole modeling area (13).

Training

EERC modeling staff attended the following training sessions:

- Modeling staff attended a NExT (Network for Excellence in Training) Advanced Petroleum Geomechanics course in Houston, Texas, November 3–7, 2014, to investigate geomechanics beyond simple elastic, isotropic behavior.

- Presented on PCOR Partnership activities at an Introduction to GIS class at North Dakota State University, December 10, 2014, in Fargo, North Dakota.

- Held in-house petrophysics and petrophysical modeling training at the EERC, May 27–28, 2015. PCOR Partnership partner Eric Pasternack of Outsource Petrophysics led the training, which included an overview of using PowerLog software. The knowledge gained in this training will be used to support the PCOR Partnership's Bell Creek modeling and simulation activities.

- Held two half-day Petrel training sessions, June 23–24, 2015. This training was led by EERC staff and was attended by several other staff members and interns. A comprehensive workflow for creating a model and performing quality control on the data is being developed to assist with this work in the future.

- Held a 4-day JewelSuite software training session, July 28–31, 2015. Baker Hughes led this training at the EERC facilities. Several EERC staff attended. The software package will be used in future geomodeling and simulation activities. One advantage of this software package is the use of VARI grids, which offer better flexibility for CMG in near-wellbore region phenomena simulation.

Additional Conference/Meeting Participation

- Attended and presented a poster entitled "Multiscale Reservoir Modeling for CO_2 Storage and Enhanced Oil Recovery Using Multiple-Point Statistics" at the 2015 European Association of Geoscientists and Engineers (EAGE) Petroleum Geostatistics Conference in Biarritz, France, September 7–11, 2015.

Task 5 – Well Drilling and Completion

The PCOR Partnership worked with Denbury, the operator of the Bell Creek oil field, to develop engineering designs for the installation of a dedicated monitoring and characterization well in the Bell Creek oil field. The feasibility of reentry into existing wells within the field which could provide additional downhole monitoring points was also evaluated.

The development of operational plans for the injection and recycling of CO_2 over the duration of the project was conducted. As the host site for the Bell Creek large-volume CO_2 injection test is an operational oil field already undergoing large-volume water injection activities, existing wells will be utilized for CO_2 injection, oil production, and monitoring. These wells are currently being reworked to accommodate long-term injection of supercritical CO_2. The EERC provided technical support for these activities; however, the actual drilling, completion, and/or reconditioning of injection and production wells was conducted by Denbury, while the EERC was responsible for the drilling of a new monitoring well in the field, with support provided by Denbury. Activities under this task commenced October 1, 2010, and concluded in June 2014.

Activities and Results

The task concluded in BP4, PY7 (June 30, 2014).

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 the Bell Creek oil field for EOR. The infrastructure development for the Bell Creek test site will be performed by Denbury. EERC personnel will document the activities, interfacing with source facility engineers and vendors and providing assistance as requested.

Activities and Results

Accomplishments during BP4, PY8 (October 1, 2014 – September 30, 2015) included the following.

It should be noted that on March 25, 2013, DOE NETL waived the requirement for an update to D85, "Opportunities and Challenges Associated with CO_2 Compression and Transportation During CCUS Activities," due March 31, 2013. A journal article (see below) continued to be under preparation in lieu of the 2013 update of the report. A 2015 update to D85 was completed.

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 geologic storage opportunities. Activities include the following.

Regional CO_2 Emission Source Characterization

In September 2015, the annual update and quality assurance/quality control (QA/QC) of the CO_2 emission source master data spreadsheet were completed (performed in conjunction with Task 1).

Capture Technology Update

A value-added report entitled "Current Status of CO_2 Capture Technology Development and Application" was finalized in January 2011. This report provided a comprehensive overview of the status of carbon capture technology development and application at that time. The overview covered technologies that apply to the three combustion platforms: precombustion, during combustion (oxycombustion and chemical-looping combustion), and postcombustion. The technologies included fall into the categories of physical and chemical absorption; physical and chemical adsorption; mixed absorption and adsorption; oxygen-, hydrogen-, and CO_2-permeable membrane processes; cryogenic processes; mineralization; and photosynthesis and chemical and biochemical reduction processes as well as alternative mass transfer techniques. The document provided an overview of the technical basis for each separation method and information on nearly 100 technologies and/or research efforts. A summary table of the capture technologies was included in the report as an appendix.

The capture technologies table (from the appendix) was adapted into a technology "tree" and made available to partners via the DSS in PY6. The tree provides basic technical information about various capture technologies as well as development status, source type applicability, and economic information (when available). As a service to the PCOR Partnership partners, an update to the PCOR Partnership capture technologies overview report and its companion technology "tree" was initiated during PY7 and continued during PY8.

CO_2 Compression Activities

The majority of research on CCS has been on capture, injection, and subsequent monitoring of the CO_2 plume in a secure geologic setting, with little attention paid to compression or pipeline transport. In March 2011, a report entitled "Opportunities and Challenges Associated with CO_2 Compression and Transportation During CCS Activities" was finalized. In lieu of an update to this report in 2013, a journal article entitled "Assessing Temporary Storage Options to Manage Variable-Rate CO_2 Emissions for Use During Enhanced Oil Recovery" was proposed and approved. A draft article was written, and a short list of appropriate peer-reviewed journals was reviewed. *Energy & Environmental Science* is the journal that has been targeted for publication. Work on refining the manuscript continued throughout PY8. The draft article will be included in a value-added report, which was undergoing final internal review at the end of PY8, early in PY9 for approval.

The 2015 update to D85 "Opportunities and Challenges Associated with CO_2 Compression and Transport During CCS Activities" was completed. The document focuses on the methods used to prepare CO_2 for pipeline transport—compression and liquefaction—discussing the basis for each method as well as any new approaches and the situations in which one approach might be preferred over another.

CCS holds the potential to reduce CO_2 emissions from large stationary sources, such as power plants and industrial facilities, thereby helping to achieve national and international CO_2 reduction goals. Although the majority of the research on CCS to date has focused on the capture, injection, and subsequent monitoring of the CO_2, efficient incorporation of compression into an integrated system may offer opportunities to reduce the cost of CCS, which could help to advance widespread implementation of the concept. This report provides basic information about CO_2 transport and compression and discusses some of the opportunities offered by thoughtful integration of them into a total CCS system.

CO_2 can be transported as a gas, a liquid, or a solid, although commercial-scale transport of CO_2 is usually accomplished as either a gas or liquid in tanks, pipelines, or ships. As a gas, CO_2 occupies less volume if it is compressed, so when commercial quantities are transported by pipeline, the CO_2 is compressed, generally to a high pressure. The volume occupied by the CO_2 can be further reduced by compressing the CO_2 to its supercritical state (over 7.4 MPa, or 1080 psi) or liquefying it.

During EOR using CO_2 or CCS activities, the CO_2 is transported by pipeline at pressures exceeding 7.4 MPa (1080 psi). This approach is based on the quantity of CO_2 that must be transported, the diameter of the pipeline required for transport of that quantity, the cost of the

compressors needed to achieve the transport pressure, the cost of any pressure booster stations required along the pipeline route, and the pressure requirements at the injection site.

Pipeline diameter is calculated as a function of allowable pressure drop per unit length, frictional resistance, CO_2 density, and CO_2 mass flow rate. A rigorous, iterative approach is used for more accurate calculations, although correlations between pipeline diameter and CO_2 flow rates can be used for estimates. The rigorous calculations show that supercritical CO_2 can be transported in a smaller and, therefore, less expensive pipeline than if the CO_2 remains in the gas phase. This approach also requires fewer recompression stations.

The CO_2 stream exiting all CO_2 capture technologies will be in the gas phase; therefore, compression is required prior to pipeline transport. Three approaches can be taken to compress CO_2 for transport in a pipeline: 1) a near-adiabatic method in which heat is neither gained nor lost by the system; 2) a second approach in which the gas-phase CO_2 is compressed in stages and cooled until the conditions are above the critical point, at which time the CO_2 is cooled to form a supercritical fluid that is pumped to the final pressure; and 3) a third method that utilizes some of the compression stages, then cools the CO_2 to form a liquid, which is pumped to the desired final pressure. The choice of compression approach for a given capture system is based upon the power demands and investment cost.

The underlying premise of the liquefaction approach is that significantly less power is required to raise pressure by liquid pumps and that the pumps are considerably less expensive than gas compressors. However, it is crucial that the refrigeration process be carefully assessed when determining the system power requirements. Two power loads must be considered for the liquefaction option: the refrigeration compressor and the cryogenic pump. Some studies have found that the liquefaction approach does not result in a more efficient or lower-cost system.

Compression is an important piece of the overall CO_2 capture plant efficiency. Selection of an appropriate compression technology for the quantity of CO_2, desired pipeline pressure, and type of capture technology is crucial. For example, centrifugal compression appears to be the most appropriate for all three capture platforms (pre-, oxy-, and postcombustion). The shock wave compression offered by the Dresser–Rand SuperCompressor is well-suited to postcombustion but not to oxycombustion. Placement of the dehydration step within the compressor train affects integration of the heat produced during compression as well as compressor design. Optimization of compression within a plant requires integration of the heat of compression so as to maximize plant efficiency. The Dresser–Rand SuperCompressor, for example, offers the opportunity for significant waste heat recovery. The best plant efficiency and capture economics will be achieved by integrating the capture technology, dehydration, compression approach, and heat integration of the compressor waste heat into the overall plant. Effective optimization will require that heat integration, dehydration design, and compressor selection be determined iteratively.

Further studies of the effects of various dehydration schemes on compression could be of value when determining the best approaches to efficiently and cost-effectively integrate the entire CO_2 capture system into a power plant or industrial facility. Additional studies of the integration of the SuperCompressor into a capture facility are also recommended as the SuperCompressor is

sufficiently different from other compressor technologies as to require a fresh examination of how heat integration and dehydration could be most effectively applied (14).

Bell Creek Test Site Infrastructure Development

An infrastructure development report (D45) will be prepared in PY9 describing the key elements of infrastructure that are required to cost-effectively distribute and inject CO_2 within an operating oil field as part of a simultaneous CCUS and EOR project. The report will contain some of the lessons learned from the Bell Creek demonstration project with respect to the capture efficiency and cost as well as all aspects of CO_2 compression and pipeline transport of the CO_2 to the injection site.

New CO_2 pipeline test data were downloaded from the Det Norske Veritas PIPETRANS site. The data are from tests performed on a highly instrumented, 1-km-long pipeline filled with CO_2 in which a hole was intentionally blown to determine 1) what happens during a pipeline rupture and 2) how CO_2 disperses from a large pipeline leak. This type of information will be included in the background sections of D45.

Conferences and Meetings

- Attended GHGT-12 in Austin, Texas, October 5–9, 2014.
- Attended the IEAGHG 3rd Postcombustion Capture Conference (PCCC3) in Regina, Saskatchewan, Canada, September 8–9, 2015.

Task 7 – CO_2 Procurement

This task documented CO_2 procurement procedures for CCS and EOR activities in the PCOR Partnership region. This task provided 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

The task concluded in BP4, PY6 (September 30, 2013).

Task 8 – Transportation and Injection Operations

This task consisted of monitoring and documenting commercial partner activities related to compression and transport of CO_2 via pipeline to the Bell Creek site, particularly as they relate to on-site injection. This task did not cover activities for the Fort Nelson site. The task was completed in September 2015.

Activities and Results

Accomplishments during BP4, PY8 (October 1, 2014 – September 30, 2015) included the following activities.

CO_2 transport and injection is being conducted by Denbury as part of the commercial EOR project. The EERC tracked these operations. The results of the CO_2 transport and injection operations were summarized in "Bell Creek Test Site Transportation and Injection Operations Report" (D49), submitted in draft form on September 29, 2015, which marked the end of the task.

Monitoring and Assessment of Commercial Operations

A cursory literature review was conducted regarding injection-related documents. Potential methods of measurement or estimation of fugitive CO_2 emissions during activities at injection sites were briefly investigated. The accuracy and application of the techniques as they apply to surface facilities were studied. It was found that there are very few, if any, field-appropriate technologies that could be used to measure very small amounts of CO_2 in the atmosphere near ground level at an injection site. These initial results led the PCOR Partnership management to stop the search for and collection of data.

In PY8, research into the effects of different impurities in CO_2 from anthropogenic sources on pipeline operation during start-up, shutdown, and at transient conditions continued. The effects of impurities on operability of injection site infrastructure were also reviewed, and the effects of CO_2 stream mass-flow variability on pipeline and injection field infrastructure were also studied. These findings were documented in a presentation given at the American Institute of Chemical Engineers 2015 Annual Meeting held November 9–14 in Salt Lake City, Utah.

Denbury is managing all injection, production, and recycle activities as part of its commercial CO_2 EOR operation. The EERC, through the PCOR Partnership, is studying the behavior of reservoir fluids and injected CO_2 to demonstrate safe and effective storage of CO_2 associated with a commercial EOR project. The PCOR Partnership is developing practices and technologies that will allow future commercial-scale CO_2 storage projects to make informed decisions regarding site selection, injection programs, operations, and monitoring strategies that maximize storage efficiency and effective storage capacity in clastic geologic formations. It is anticipated that many of the lessons learned from this EOR operation will also apply to CCS projects in the future.

The EERC prepared D49 to summarize the CO_2 pipeline and the Bell Creek injection facilities. Because the EOR operation is a business activity and much of the information is considered to be business-sensitive, this report was compiled exclusively using information that has previously been publicly disclosed.

The CO_2 for the Bell Creek site is sourced from the ConocoPhillips Lost Cabin Gas Plant and the ExxonMobil Shute Creek gas-processing facility. A target rate of 1.4 million m^3/d (50 MMcfd) CO_2 that was previously vented from the Lost Cabin Gas Plant is now compressed and transported via pipeline to Bell Creek. The quantity of CO_2 that is contributed to the Bell Creek site by the Shute Creek Plant is not publicly available.

The CO_2 is transported to the Bell Creek site using Denbury's Greencore pipeline, which is approximately 373 km (232 mi) long. The pipeline was designed to transport as much as 20.5 million m^3/d or 38,150 t/d (725 MMcfd or 42,053 short tons/d) CO_2, although plans called

for the Greencore pipeline to initially transport a target rate of 1.4 million m^3/d, equal to 2630 t/d (50 MMcfd or 2900 short tons/d) (15). The pipeline right-of-way (ROW) runs through private (65%), federal (30%), and state (5%) land (16). The pipeline is 20 in. in diameter and was designed for a maximum operating pressure of 15.2 MPa (2200 psi). Steps taken when constructing the pipeline were standard pipeline construction sequence steps and included survey and staking; clearing; front-end grading; ROW topsoil stripping; restaking the trench centerline; stringing pipe; lining-up and welding pipe; x-ray inspection and weld repair (if necessary); coating of field welds; trenching; inspection and repair of coating; lowering pipe into the trench; padding, backfilling, and rough grading; hydrostatic testing and final tie-in; and replacement of topsoil, cleanup, and full restoration. Construction began in August 2011, and the pipeline was commissioned and started up in December 2012. The pipeline cost an estimated US$285 million (16, 17).

The Bell Creek EOR facility follows a scheme in which the water and CO_2 that are separated from the oil are reinjected. Fluids from the individual wells are transported through flow lines and enter the header system of the production manifold in the manifold building. From the production manifold, the commingled stream flows to the process building for separation (18). The oil is piped to oil storage and sales tanks. The water is piped to temporary water storage tanks prior to being pumped back to the field for reinjection. The CO_2 is piped to the compressor building. Following pressurization, the CO_2 discharges back to the manifold building where it is combined with the purchase CO_2 for reinjection (18). Water and CO_2 are distributed to the field through injection manifolds (18).

The methods used by Denbury to plan, construct, and operate the Greencore pipeline for EOR may also apply to CO_2 transport during a future CCS project. Likewise, many of the surface facilities associated with CO_2 EOR are similar to those that would be needed for storage of CO_2 within any secure geologic formation. While the Bell Creek project is an EOR project rather than a CCS project, the data being collected during all phases of this EOR project will be invaluable in helping to prove the usefulness of the CCS concept as a way to effectively decrease atmospheric CO_2 levels (19).

Task 9 – Operational Monitoring and Modeling

This task develops 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, PY8 (October 1, 2014 – September 30, 2015) include the following.

Bell Creek Test Site

CO_2 Injection Continued

1.5 Million Metric Tons of CO_2 Injected

Denbury is developing the Bell Creek oil field in a phased approach, with each development phase corresponding to approximately 12 months of injection before the next development phase is brought online. *Continuous CO_2 injection has been occurring at the Bell Creek oil field since May of 2013*, primarily in the Phase 1 development area. Currently, active injection has expanded into the Phase 2, 3, and 4 development areas. The amount of injected gas is being reported to MBOG by Denbury on a monthly basis, although there has been a lag between when the data are supplied to MBOG and when they are made publicly available.

Milestone [M] 49 marks that 1,500,000 metric tons of CO_2 was injected at the Bell Creek oil field, which occurred in November 2014. Reported MBOG injection totals were 1,660,570 metric tons of total gas (composition >95% CO_2) from 46 wells in the Bell Creek oil field as of November 30, 2014 (Figure 11). The CO_2 is sourced from the Lost Cabin gas-processing facility, which processes gas from the Madden Field in the Wind River Basin of Wyoming and the Shute Creek gas-processing facility, which processes gas from the LaBarge Field in the Green River Basin of Wyoming. Subsequent monthly injection totals will be reported to DOE as part of the PCOR Partnership's regular quarterly reporting once the data become available (20).

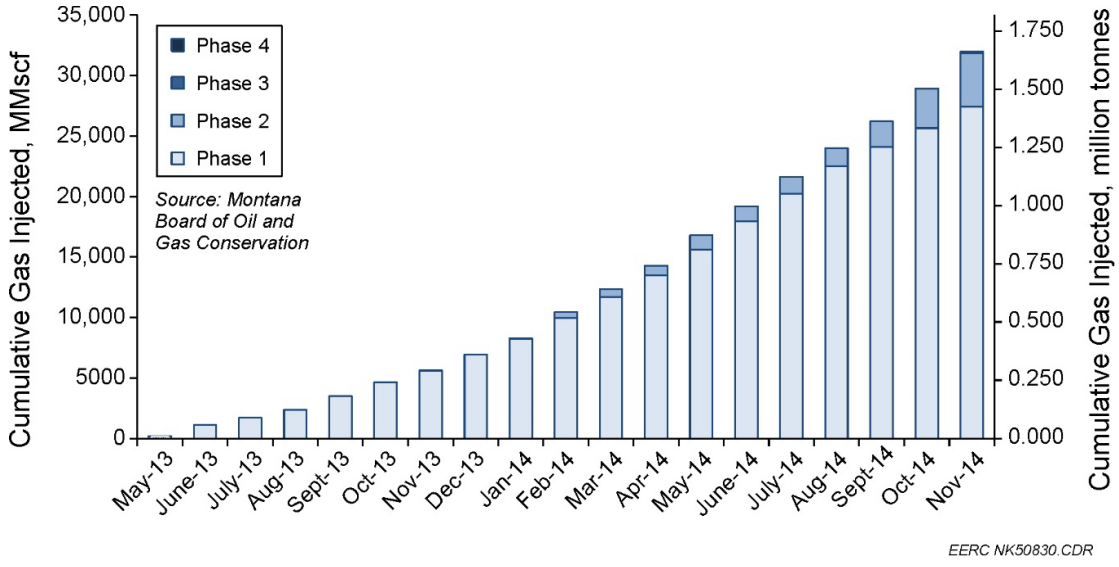


Figure 11. Monthly breakdown of cumulative gas injection by development phase at the Bell Creek oil field from May 2013 to November 2014.

Injection and Production Data Acquisitions

Injection and production data are acquired and supplied from Denbury utilizing oil field manager (OFM) database software. Injection and production data are also made publicly available through the online MBOG database. The MBOG data are compiled, QA/QC-checked, and used to report CO_2 injection totals regularly to DOE. CO_2 injection and production data acquired from the OFM database are used for data processing/interpretation for MVA-related activities and are integrated into Bell Creek simulation activities.

The most recent publicly available data were to determine that cumulative total CO_2 gas injection was 2,539,042 metric tons through April 30, 2015. This value represents the total gas volume injected which includes purchase and recycle streams and is NOT corrected for a gas composition of approximately 96% CO_2 (Table 8).

Table 8. Bell Creek CO_2 Gas Injection Totals for April 2015 (cumulative totals May 2013 to April 2015)*

	April 2015 Injection
Total, Mscf	3,280,561
Total, U.S. tons†	187,643
Total, metric tons†	170,392
Cumulative Total, Mscf ‡	48,884,167
Cumulative Total, U.S. tons†‡	2,796,097
Cumulative Total, metric tons†‡	2,539,042

Source: MBOG database.

* There has been a lag in posting of injection/production volumes to the MBOG database. Total gas injection volumes are ***NOT CORRECTED*** for gas composition and include the combined purchased and recycled gas streams.

† This was calculated utilizing a conversion of 17.483 Mscf/U.S. ton and 19.253 Mscf/metric ton.

‡ Cumulative totals are for the period from May 2013 to the month listed.

As of July 31, 2015, the most recent month of record, 2.383 million tonnes of total gas (composition of approximately 96% CO_2) has been purchased for injection into the Bell Creek Field, equating to an estimated 2.301 million tonnes of associated CO_2 storage (Table 9). A separate methodology from that used to calculate total gas injected was used to calculate a cumulative associated CO_2 storage volume estimate by correcting the gas purchase volume (approximately 96% CO_2) obtained from Denbury's custody transfer meter with gas compositional data.

Table 9. Cumulative Total Gas Purchased and Estimated Associated CO_2 Storage Volumes for the Bell Creek Field[1]

	July 2015 Gas Volume
Monthly Total Gas Purchased, MMscf[2]	1928
Monthly Total Gas Purchased, million tons[2]	0.110
Monthly Total Gas Purchased, million tonnes[2]	0.100
Cumulative Total Gas Purchased, MMscf[2,3]	45,876
Cumulative Total Gas Purchased, million tons[2,3]	2.624
Cumulative Total Gas Purchased, million tonnes[2,3]	2.383
Cumulative Total CO_2 Stored, MMscf[3,4]	44,299
Cumulative Total CO_2 Stored, million tons[3,4]	2.534
Cumulative Total CO_2 Stored, million tonnes[3,4]	2.301

[1] Conversion factors of 17.483 Mscf/ton and 19.253 Mscf/tonne were used to calculate volumes.
[2] Total gas purchased volumes are ***NOT CORRECTED*** for gas composition.
[3] Cumulative totals are for the period from May 2013 to the month listed.
[4] Total gas CO_2 stored volumes are ***CORRECTED*** for gas composition.

Implementation of Monitoring Plan

2 years of Near-Surface Assurance Monitoring Completed

Surface and shallow-subsurface water and soil gas chemistries, as well as the naturally occurring chemical variability within these systems, were evaluated via collection and analysis of water and soil gas samples throughout the Bell Creek Field (Figure 12). As of June 2015, the assurance-monitoring program (detailed in Table 10) has consisted of three full-field events and a series of 13 phase-focused events. The phase-focused events provide a higher assurance-monitoring frequency in the development phases of the Bell Creek Field undergoing active CO_2 injection at the time of monitoring.

The acquired data sets have provided key insight regarding how near-surface research-monitoring programs could be transitioned toward a more commercially viable long-term assurance-monitoring strategy. For example, workflows were developed to semiautomate the analysis and characterization process that could be adapted into site-specific intelligent monitoring approaches. Baseline data spanning an 18-month period prior to injection, supplemented by 2 years of assurance-monitoring data, have generated a defensible data set characterizing the natural variability of near-surface environments. The monitoring program has overall been sufficient to detect, characterize, and attribute multiple anomalies to naturally occurring processes and has successfully demonstrated no impact to near-surface environments. The methodology and lessons learned developed at Bell Creek will allow future CCUS operators to make informed decisions regarding site-specific monitoring programs at other commercial-scale injection sites throughout the region (21).

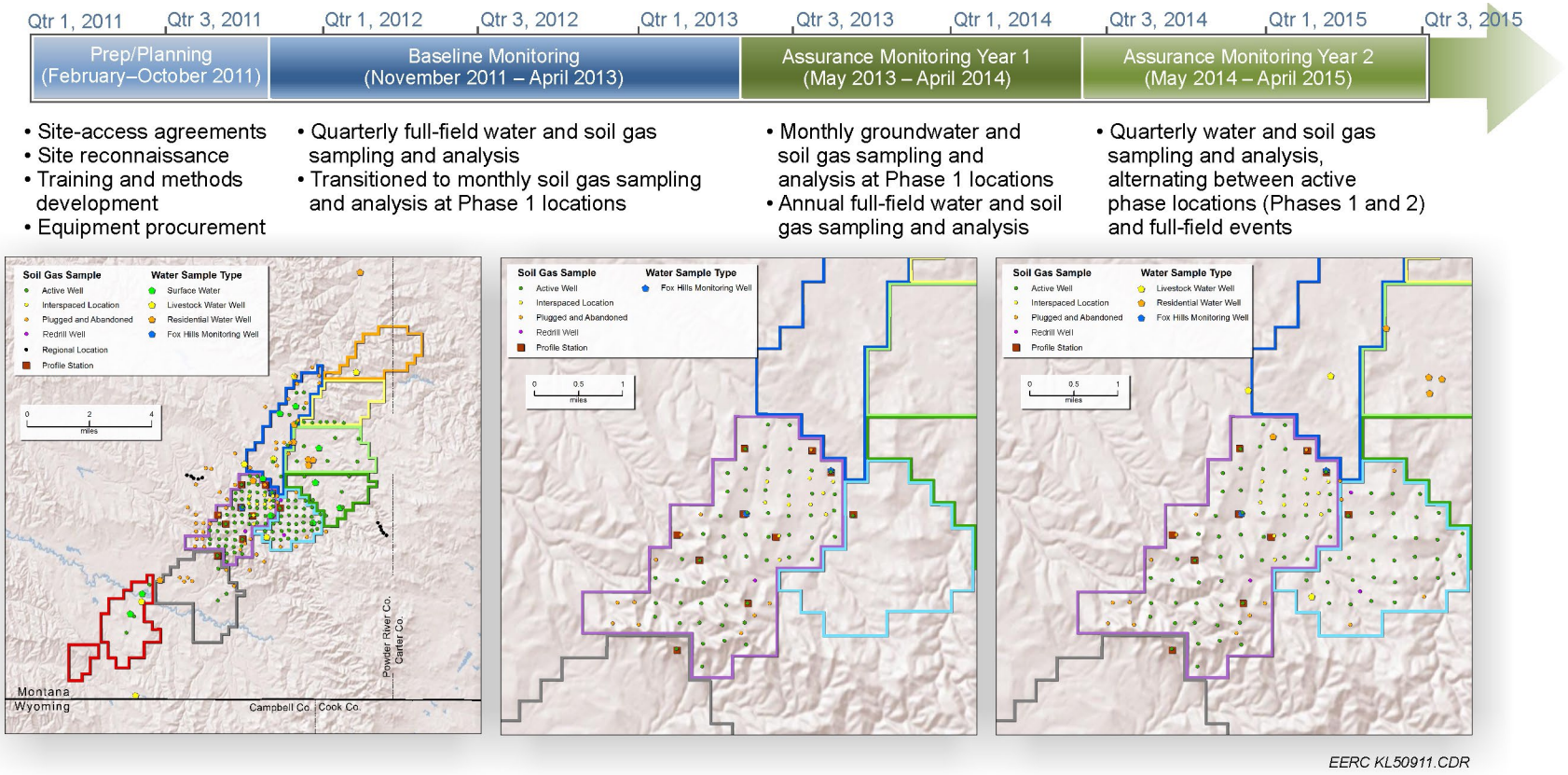


Figure 12. Near-surface monitoring program time line and water- and soil gas-sampling locations collected for various sampling events between November 2011 and April 2015.

Table 10. Water- and Soil Gas-Sampling and Analysis Categories Collected During Assurance-Monitoring Period Between May 2013 and April 2015

Sample Type	Sampling Event: Full-Field (Nov-13, Sep-14, Apr-15)	Sampling Event: Phase 1 Monthly (May-13 to Apr-14)	Sampling Event: Phases 1 and 2 Quarterly (Jun-14, Dec-14)	Description
Water Samples				
Surface Waters	10			Ponds, streams, etc.
Livestock Water Wells	7		3	Shallow groundwater wells
Residential Water Wells	8		5	Shallow groundwater wells
Fox Hills Monitoring Wells	2	2	2	Two purpose-built groundwater-monitoring wells screened in the Fox Hills Formation (the deepest regional underground source of drinking water)
Total Water-Sampling Locations	27	2	10	
Soil Gas Samples				
Active Wells	121	57	89	Injection/production well locations
Interspaced Locations	10	10	10	Between active well locations
Plugged and Abandoned (P&A) Wells	56	11	16	P&A well locations (sampled in a three-directional spot pattern at each location)
Redrilled Wells	3	1	3	Previously P&A well locations during baseline sampling (sampled in a three-directional spot pattern)
Regional Locations	10			Provides background soil gas concentrations for QA/QC
Profile Stations	10	10	10	Ten purpose-built fixed-location soil gas profile stations (sampled at depths of 3.5, 9, and 14 feet)
Total Soil Gas-Sampling Locations	210	89	128	
Total Sampling Locations	**237**	**91**	**138**	

A SOP was prepared in April 2015 for prioritizing Bell Creek groundwater sample laboratory analyses based on field analytical results. Tables were generated of recorded ranges for pH, alkalinity, and conductance at all groundwater-sampling locations to aid the sampling crew in detecting anomalies while in the field.

The team updated the internal, interactive database-driven map product with data from the September 2014 and PY8 sampling events. Developed in PY7, the product is capable of querying, displaying, and enhancing rapid targeted comparison and interpretation of the large analytical data sets from near-surface monitoring data from both the baseline and operational monitoring periods to improve data accessibility and efficiency of analysis between project team members and stakeholders.

Year 3 of assurance monitoring has continued the Year 2 approach of quarterly soil gas and water sampling and analysis, alternating between select locations (Phase 1 and 2) and full-field events. A Phases 1 and 2 quarterly sampling event occurred in June 2015, and a full-field sampling event occurred in August 2015 (see Table 10 for sampling details).

Working with Denbury, a plan was developed to collect periodic oil and gas samples from select wells in the Phase 1 area. The plan was to collect one gas and one oil sample from each of the three production wells (32-02, 56-14, and 05-06) on an estimated quarterly basis for chemical composition. Additional injection-phase near-surface monitoring activities included collection and analysis from the incoming purchase supply as well as the recycled CO_2 streams to analyze gas composition. Specific collection dates of these samples are summarized in Table 11.

Table 11. Oil and CO_2 Gas Stream Sampling and Analyses

Stream(s)	Dates Sampled
Production: Oil and CO_2 Gas[1]	Sep 2014[2], Nov/Dec 2014, Jan 2014[3], Mar 2015, Jul 2015
Purchase/Recycle: CO_2 Gas[4]	May 2014[5], Jun 2014, Jul 2014, Sep 2014, Oct 2014, Apr 2015, Jul 2015, Sep 2015

[1] Wells 56-14R, 32-02, and 05-06 unless otherwise noted.
[2] Wells 56-14R and 32-02 only.
[3] Well 05-06 only.
[4] Both purchase and recycle streams unless otherwise noted.
[5] Purchase stream only.

The team is working on developing alternate strategies for reduced near-surface monitoring, moving toward a commercially viable strategy, specifically regarding frequency and focusing on key indicator analytes now that the focus area is well characterized. Expansion into additional development phases is also being evaluated with the site operator.

Deep MVA Program Activities

The primary purpose of deep subsurface monitoring is to track the movement of CO_2 in the subsurface in order to evaluate the recovery efficiency of the CO_2 EOR program and to predict the

ultimate fate of CO_2 within the storage reservoir. Additional benefits of the deep subsurface monitoring program include 1) early detection of wellbore leakage or identification of potential leakage pathways that may require remediation; 2) identification of potential injectivity issues; and 3) the ability to monitor and account for injected CO_2 to monetize carbon credits, potentially offsetting project costs.

The PCOR Partnership deep subsurface MVA program utilizes a combination of wellbore technologies, such as pulsed-neutron tools, permanent downhole monitoring (PDM), 3-D VSP acquisition, passive seismic acquisition, and production/injection data to measure reservoir changes during injection, track the vertical and lateral extent of fluid and CO_2 movements during the injection process, and account for injected CO_2. In PY8, the following activities were used to gather operational data for comparing to baseline data acquisitions and provide references in the field to monitor CO_2 as it moves between injectors and producers.

Injection-Phase PNL Activities

PNLs are acquired via wireline conveyance in conjunction with a crane truck. Tool specifications allow for acquisition through 2⅞-inch tubing and are run with wellhead pressure control equipment (wireline blowout preventer [BOP], lubricator, and grease injection). Logging operations require each well be sequentially taken off-line (production or injection) and take approximately 8 hours per well from rig up to rig down. Scheduling and acquisition are coordinated between Denbury, the EERC, and the logging service provider to allow for minimal impact to commercial CO_2 EOR operation (22).

PNLs provide a quantitative assessment of water, oil, and CO_2 saturations in the near-wellbore environment. PNL repeats were completed within and surrounding the Phase 1 development area to compare against baseline logs and monitor for vertical CO_2 migration in the near-wellbore environment and changes in water, oil, and gas saturations to evaluate conformance and storage efficiency as follows:

- Liquid–gas saturation from reservoir depth up to 200 ft of surface
- Water, oil, and CO_2 saturation over the Muddy Formation (storage reservoir)

Initial Analysis for First Large-Scale Repeat Pulsed-Neutron Logging Campaign Post-Significant CO_2 Injection Completed

The PNL logging campaign has consisted of two parts: running a baseline set of logs and running a series of repeat logs to compare against the baseline (Figure 13). The baseline logs were acquired from 33 wells from November 2012 to June 2013.

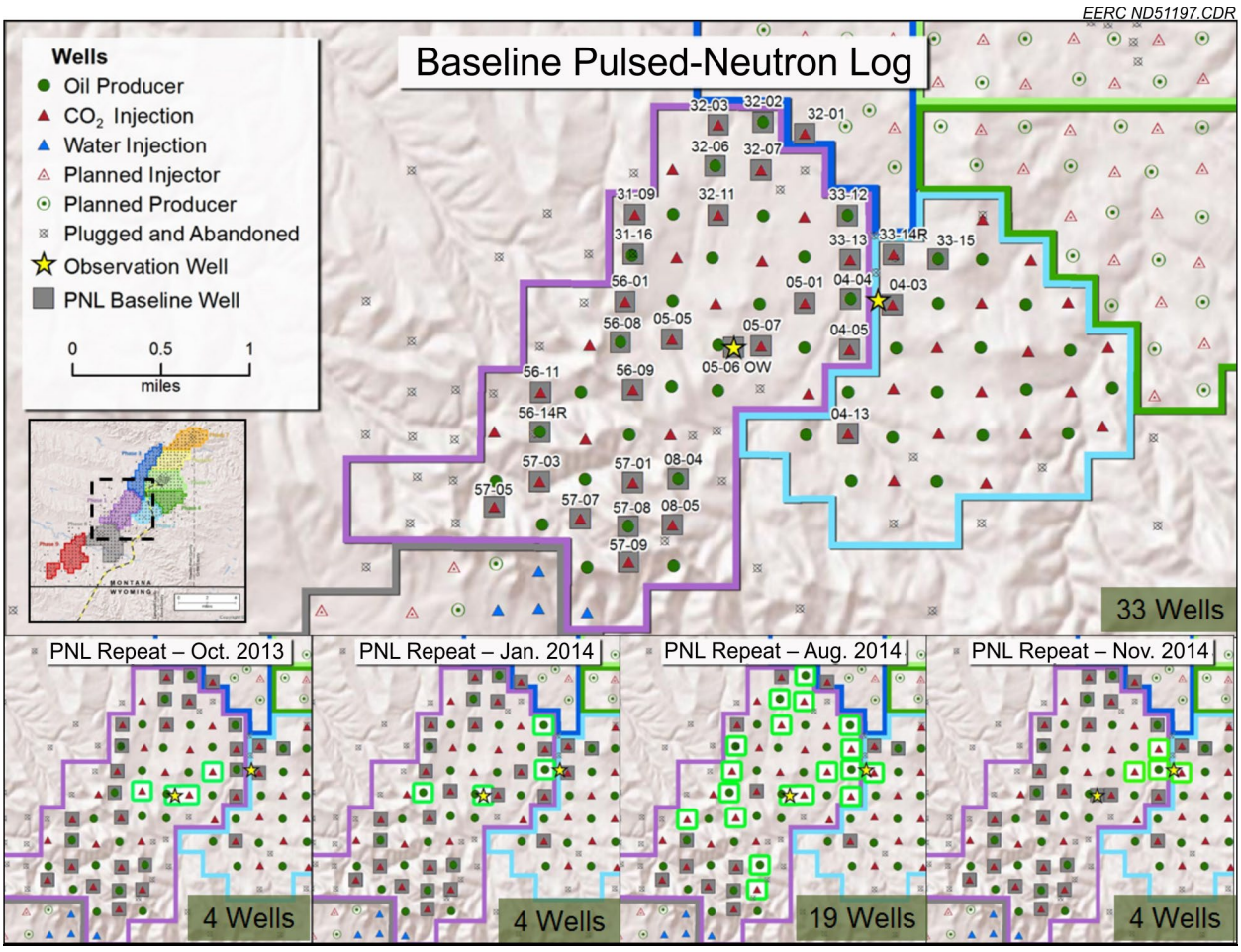


Figure 13. Map of the baseline and repeat PNL program throughout the Bell Creek oil field as of June 2015.

Two four-well PNL monitor tests were performed (during October 2013 and January 2014) in advance of a large-scale repeat. The monitor tests were conducted to demonstrate that PNLs had sufficient capability of resolving changes in water, oil, and gas saturation through the reservoir interval and to test their sensitivity to those changes. Based on the results of the monitor tests, the first large-scale PNL monitor campaign consisting of 19 wells occurred in August 2014. Following the full-scale repeat, a third PNL monitor test was performed in November 2014 on four wells to determine the short-term sensitivity of PNLs in relation to field injection and production rates in an established flood area and to provide a concurrent tie between near-wellbore saturations from PNLs with a time-lapse seismic acquisition. An initial analysis of the repeat logs for the first large-scale repeat campaign has been completed. Key findings from this analysis include the following:

- Inelastic capture (IC) logs interpreted in conjunction with sigma logs were capable of distinguishing between CO_2, oil, and water saturations in the low-salinity reservoir (<5000-ppm total dissolved solids) (Figure 14).

- CO_2 saturations of up to 40% were observed in the injection horizon.

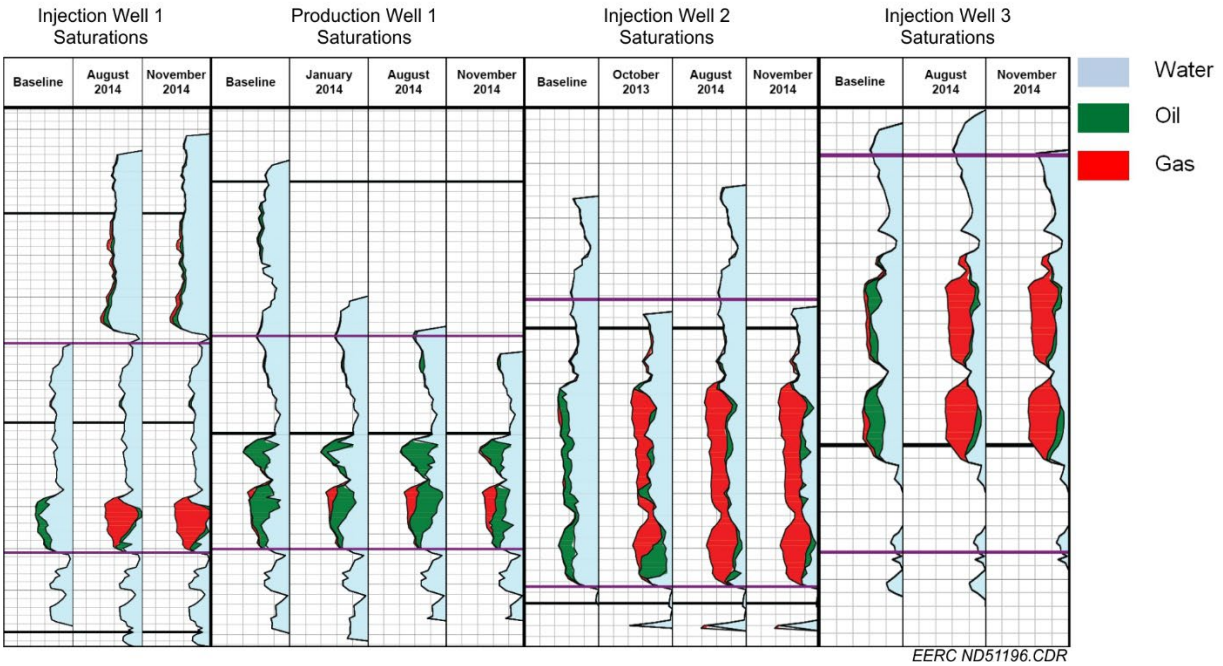


Figure 14. Changes in fluid saturations between baseline and repeat campaigns for four selected wells. Purple lines represent the top and bottom of the target injection interval.

- CO_2 is contained within the target injection horizon, demonstrating effective confining layers.

- Time-lapse changes in saturation are providing enhanced insight into associated storage performance.

- Time-lapse PNLs have demonstrated a continually evolving saturation profile over the first 18 months of active injection (see Figure 14).

In addition to the analysis of saturation changes, the PNL results are being used in a variety of ways to support the characterization, modeling and simulation, and risk assessment activities being performed to study associated CO_2 storage at Bell Creek. Workflows are being developed to use near-wellbore saturation data from baseline PNLs to better understand uncertainty in existing simulation models and guide where additional characterization is needed to improve reservoir simulations. PNLs are also being used to provide a more accurate understanding of the geologic formations in the field by updating formation tops and thicknesses, creating a structural model above the reservoir, and updating rock properties in the geologic model. Data from the PNLs have helped to characterize potential above-zone monitoring intervals. Additionally, near-wellbore gas saturation data from PNLs were used in conjunction with dynamic simulation results to successfully determine if CO_2 saturations in the reservoir were sufficient to image using seismic techniques prior to deploying a repeat 3-D seismic survey. Finally, the PNLs are undergoing statistical analyses to help reduce error in comparing baseline and repeat logs to assist in monitoring for the presence of CO_2 above the reservoir (23).

Pressure and Temperature PDM Injection-Phase Activities

Real-time wellhead pressure, temperature, flow, and well test data (surface casing pressure, production casing pressure, flowline pressure, tubing pressure, mass flow, recycling volumes, and production volumes) were collected periodically for all active injection and production wells fieldwide. These measurements were accessed with permission from Denbury and will continue to be collected during the operational phase of the project at the same frequency (22). The following activities were performed in PY8:

- Acquired and processed near-continuous data (5-minute intervals) since October 1, 2013, from three casing-conveyed downhole pressure and temperature gauges (05-06 OW):
  - Lower facies of the Muddy Sandstone
  - Upper facies of the Muddy Sandstone
  - Niobrara (thin sand lense within the primary seal)

- Acquired and processed near-continuous data (4-hour intervals) since October 1, 2013, from a fiber optic distributed-temperature system (05-06 OW):
  - 1-meter intervals from ~4700 ft to surface

- Specific PDM data acquisition dates and interpretations are summarized below:
  - Downloaded PDM (MOREVision and Qorex units) data and cleared memory from 05-06 OW data system on October 24, 2014.

  - Traveled to Bell Creek January 14–16, 2015, to download data from the Qorex and MOREVision systems, swap hard disk drives on the GeoPro system, and continue reservoir surveillance and analysis of continuous PDM data in the 05-06 OW well.

  - Spoke with Trevor MacDougal of Qorex regarding a distributed temperature sensing (DTS) data anomaly which occurred between April 4 and May 21, 2014. The analysis determined that the system is performing within the system accuracy specification of ±2°C and that temperature offset is particularly sensitive to the temperature change of the surface cable near the freezing point of 0°C.

  - Downloaded PDM data (January 15 – April 28, 2015) from the MOREVision and Qorex units.

  - Traveled to Bell Creek to download PDM data through June 2015 as well as swapped out the GeoPro HDDs (hard disk drives).

  - Processed PDM data through June 2015.

  - Corresponded with MOREVision in September 2015 regarding difficulties with existing unit and received a replacement unit. Installation will occur in PY9.

Injection-Phase Seismic Efforts

Preinjection baseline seismic surveys were acquired at Bell Creek in PY5 and PY6. A 40-square-mile 3-D surface seismic survey was completed in September 2012. The main focus of this survey was for reservoir characterization and to provide a baseline for subsequent postinjection time-lapse surveys. Baseline 3-D VSPs were conducted in the 05-06 OW and 04-03 OW wells in May 2013. The VSPs were acquired with equipment consisting of a 60-level retrievable geophone array in the 05-06 OW well and a permanently installed 50-level geophone array cemented into the 04-03 OW well. The VSP data were acquired to study the usefulness of VSPs in a CO_2 EOR context, provide a detailed subsurface characterization of the permeability barrier between Phases 1 and 2, and as a baseline for subsequent time-lapse surveys that would provide seismic images of CO_2 saturation changes. Between seismic surveys, the permanently installed geophone array was used for passive seismic monitoring of the field starting in May 2013 (PY6) to the present, including all of PY8.

Seismic efforts specific to PY8 include two repeat 3-D surface surveys and a repeat 3-D VSP. From October 19 to November 11, 2014, EERC personnel were in the Bell Creek Field to witness seismic data collection and oversee PNL well logging. An 11.6-square-mile repeat 3-D seismic survey focused on Phases 1 and 2 was shot October 19–30, 2014. Concurrent with the surface seismic acquisition, a repeat 3-D VSP was acquired passively using the equipment in the 04-03 OW well by incorporating shot locations for the VSP into the acquisition planning for the surface 3-D survey (Figure 15). The borehole array continued its normal continuous recording with no additional staff in the field to perform recording activities. Later at the processing center, the VSP records were extracted from the continuously recorded data by matching the GPS (global positioning system) times from the source records with the GPS times on the borehole array records.

Figure 15. Vibroseis trucks are used to conduct 3-D VSP surveys in the Bell Creek Field.

Paulsson, Inc., performed the 3-D VSP processing, which included reprocessing of the baseline survey from the 04-03 OW well. The processed data volume, intermediate processed data sets, and comprehensive backup material concerning the processing were received which included images of a substantially more complicated structure within the permeability barrier than had been previously seen on surface seismic data.

Passive seismic monitoring using the borehole array at 04-03 OW continued throughout PY8. Passive monitoring involves recording 24 hours a day, 7 days a week to detect microseismic events that may occur within the field as a geomechanical response due to injection processes or larger seismic events originating outside the field. Routine hard drive swaps occurred every 6–8 weeks, as needed, when data drives filled. Status e-mails from the system and remote log-ins alert the monitoring staff to system needs. An issue with data collection occurred in late June 2015 when the aboveground recording system was unable to power up the downhole array. On July 6–8, 2015, EERC personnel, with guidance and borrowed test equipment from Geospace (the recoding system vendor), traveled to Bell Creek to troubleshoot and fix the recording system. The system was repaired and the downhole array powered up and returned to operation. Evidence suggested the issue was related to an extreme weather event in the field.

To provide useful information, the passive monitoring data need to be sifted for microseismic events, including their time, location, and magnitude. The first 13 months of passive data collected were processed by the contractor that installed the system. To address the volume of data collected since then, the EERC purchased a SuperMicro workstation with multiple hot-swap drive bays to handle the large amount of data collected and GeoTomo MiVu software capable of sifting for events and calculating their locations and magnitudes. A graduate student intern worked on processing the data using GeoTomo software. Work included constructing the 3-D velocity model. Additional work is pending.

From mid-May to July 31, 2015, analytical work was done to assist the preparation of a 3-D geomechanical earth model to be used for dynamic simulation. A reprocessed version of the 40-square-mile baseline seismic data volume was used to perform a simultaneous prestack inversion. The unstacked gathers of reflection time amplitude were inverted to compute three separate data volumes in depth: Young's modulus, Poisson's Ratio, and density. With these three parameters, any other geomechanical parameter can be calculated as part of a 3-D model over the entire 40-square-mile acquisition area.

A third 3-D surface seismic acquisition was completed on September 7, 2015 (Figure 16). This acquisition expanded the area covered by seismic baseline data farther to the north, and acquired time-lapse seismic data over additional areas with active CO_2 injection, specifically Phases 2 and 3. In total, the survey covered approximately 26 square miles and consisted of successful acquisition of 6622 receiver locations and 7253 source locations.

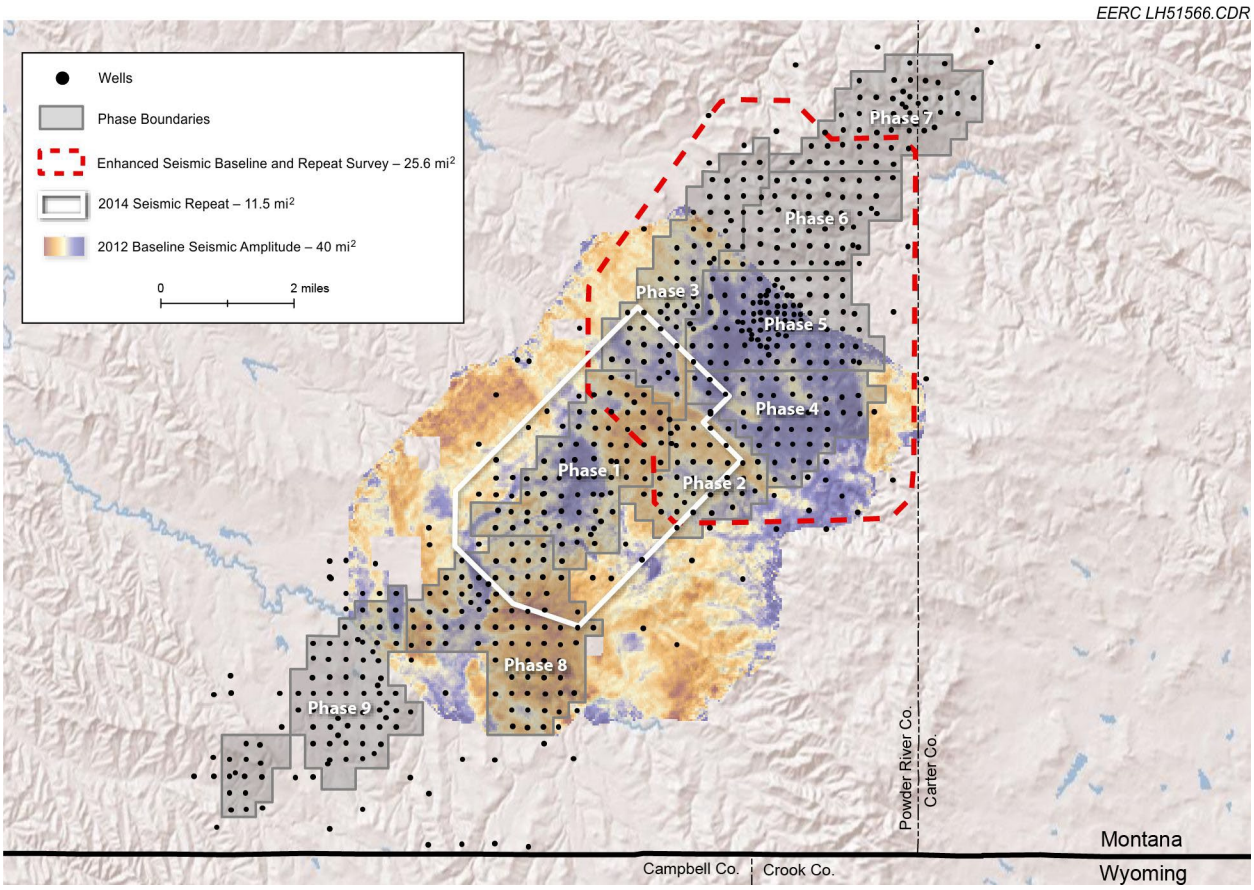


Figure 16. Map of existing 3-D seismic baseline. Fall 2014 time-lapse 3-D monitor seismic survey and planned 2015 extended baseline and coincident time-lapse 3-D monitor seismic survey extent.

Reservoir Modeling

Attributes such as injectivity, fluid production, and reservoir dynamics will be modeled using relevant software packages. The ultimate fate of the CO_2 over short-, intermediate-, long-, and extremely long term time frames will be predicted. A report on the specific results of the Bell Creek oil field simulations was prepared in August 2011 and updated in August 2012, August 2013, August 2014, and August 2015 (D66). The updated reports from 2013 remain under review by Denbury and have not yet been finalized.

With the goal of providing a comprehensive assessment of associated CO_2 storage behavior, the PCOR Partnership has initiated a modeling and numerical simulation effort as part of its adaptive management approach to CO_2 storage program development. The modeling and simulation efforts include 1) characterizing and modeling the study area; 2) developing a robust PVT model to predict the miscibility behavior of the system and to aid in compositional simulation; 3) history-matching the constructed dynamic reservoir models; and 4) running predictive simulations to aid in monitoring long-term behavior of injected CO_2.

The update to D66 encompasses the modeling and simulation work completed since August 2014 and includes 1) the construction of a Bell Creek reference model to enable consistency across the various geologic modeling efforts; 2) the incorporation of 33 baseline and 19 repeat PNLs to improve the static and dynamic geocellular models; 3) history-matching and predictive simulations of the combined Phase 1 and 2 area (clipped from the V2 geologic model); and 4) construction of a V3 geologic model, developed to incorporate 3-D surface seismic data and portray a new understanding of the reservoir's depositional history.

The reference model has been constructed to house key data sets associated with the Bell Creek Field, including 751 wells, field and processed logs, core analyses, structural tops, cultural surface boundaries, completed simulation results, ground surface elevation from lidar, and 3-D surface seismic data. The reference model will be important for future Bell Creek efforts to provide a foundation to ensure consistency across various modeling efforts.

Individual Phase 1 and 2 simulation models, previously developed and reported in Liu and others (10), have been combined to form a new simulation model that enables simulated fluid flow between the phases. Simulation work discussed in D66 includes 1) history-matching 47 years of field records with primary production, waterflooding, and CO_2 EOR in the Phase 1 and 2 areas; 2) analyzing fluid saturation distribution in the reservoir; 3) identifying cross-boundary fluid flow between Phases 1 and 2; and 4) predictive simulations of continuous CO_2 injection (CCI) and water alternating gas (WAG) in both Phase 1 and 2 areas to assess oil recovery, CO_2 storage, and CO_2 utilization factor.

Results of predictive simulations for the Bell Creek project include the following:

- The WAG case results in less hydrocarbon pore volumes injected (HCPVI) than CCI for the same injection time (WAG injects 3 HCPV, while CCI injects 4.65 HCPV). This is because CO_2 has lower density and viscosity than water; more pore volumes of CO_2 can be injected into the reservoir (in comparison to water) under the same pressure constraints.

- CCI results in approximately twice the injected CO_2 in comparison to the WAG case and approximately 1.7 times more CO_2 stored (however, more CO_2 is produced with oil in CCI mode). Also, CCI requires more injected CO_2 to produce the same amount of oil in comparison to the WAG case.

- During the simulated WAG case, the CO_2 utilization factor (i.e., amount of CO_2 needed to produce 1 barrel of oil) dropped below 10 MMscf/bbl after 1 HCPVI. This decreased to 7 MMscf/bbl when 3 HCPV was injected in the WAG mode. The value remains above 10 MMscf/bbl, even after 4 HCPVI, in CCI mode. These results agree with similar results published in Ettehadtavakkol and others (24).

- The incremental oil recovery from CCI and WAG is almost the same, while the CO_2 HCPVI of WAG is 35% less than that of CCI. Thus WAG has higher sweep efficiency and can utilize CO_2 better than CCI in the EOR process.

It should be noted that the previously developed V1 and V2 geologic models (and subsequently the simulation results discussed above) have roots in the conventional Bell Creek

depositional interpretation of stacked barrier bar sands within a large, Galveston Island-style depositional environment oriented approximately northeast to southwest. Recent investigations discussed within D66 (history-matching during simulation efforts, incorporation and interpretation of 3-D and 4-D seismic surveys, and comparison of PNL measured oil saturations with modeled oil saturations) have indicated this interpretation should be reexamined in renewed (V3) modeling efforts.

Integration and interpretation of the Bell Creek 3-D baseline surface seismic data lend support to a new depositional model with an interpreted local, transgressive barrier bar (as seen to be related to character in the upper Bell Creek sand interval) in Phases 1 and 2, indicating a large shift in inferred shoreline orientation from previous studies (approximately northwest to southeast). As such, a V3 model is under construction which will incorporate the new geophysical data, results from the history-matched simulation model, and the new geological interpretation. This model will then be used along with the V2 model in the history-matching and predictive simulation efforts to better understand the long-term fate of the injected CO_2 (11).

Fort Nelson Test Site

Spectra has currently suspended activities on the Fort Nelson CCS Feasibility Project pending the development of an economically viable business model for implementation. EERC staff met with David Moffatt and Mark Jenkins of Spectra on March 12, 2015, in Calgary, Alberta, Canada. Mr. Moffatt and Mr. Jenkins provided a summary update of the status of the Fort Nelson project. The following activities were performed in PY8:

- Presented "Application of Canadian Standards Association Guidelines for Geologic Storage of CO_2 Toward the Development of a Monitoring, Verification, and Accounting Plan for a Potential CCS Project at Fort Nelson, British Columbia, Canada" at GHGT-12 in Austin, Texas (paper available at www.sciencedirect.com; citation for the paper is listed in the Phase III Products section, by author, under Conference Papers).

- Received an invitation from CSIRO (Commonwealth Scientific and Industrial Research Organization) to be a reviewer of the efforts to develop ISO (International Organization for Standardization) standards for geologic storage of CO_2.

Modeling Training Courses

- Attended the CCUS Workshop in Midland, Texas, October 23–24, 2014.

- Several team members attended a Webinar hosted by Computer Modelling Group Ltd. (CMG) regarding numerical tuning during simulation, April 15, 2015. Numerical tuning is used to improve the simulation models to provide more accurate results.

- Attended the 2015 U.S. Rock Mechanics Geomechanics Symposium and Workshop in San Francisco, California, June 27 – July 1, 2015.

- Staff traveled to Houston, Texas, to attend CMG's CMOST, WINPROP, and reservoir training July 8–15, 2015. The modules are used to get better PVT data and improve simulation efficiency using effective experimental design algorithms.

- Attended CMG EOR Modeling Using GEM training course in Calgary, Alberta, Canada, August 1–9, 2015. More functions were added for CO_2 EOR, phase behavior, and storage simulation to improve the prediction.

- EERC personnel attended the CMG Webinar "Mechanistic Modelling of Low-Salinity Waterflooding in Clastics and Carbonates," August 6, 2015. Fluid–rock interaction mechanisms were added to the models to mimic the physical and chemical processes in carbonates reservoirs.

- Attended Petrel Fundamentals Training in Houston, Texas, September 28–29, 2015. Geological modules are used to construct reservoir framework and well structure, bridging large-scale geologic models to dynamic simulations.

DOE Carbon Storage Project BPMs

The PCOR Partnership is playing an active part in the revision/redevelopment of DOE Carbon Storage Project BPMs. There are three DOE BPMs relevant to PCOR Partnership Task 9 activities. These BPMs are expected to be completed in 2016 or 2017. The following activities were performed in PY8.

PCOR Partnership personnel participated in the kickoff Webinar meeting for the update of the DOE Best Practices for Monitoring, Verification, and Accounting of CO_2 Stored in Deep Geologic Formations on April 28, 2015 (last updated in 2012). Personnel participated in additional conference calls discussing the BPM. The PCOR Partnership took the lead in suggesting a combined approach for outline options by process or by formation to appeal to a wider audience as well as adding a conclusion/summary section, both of which were accepted by the DOE RCSP team. PCOR Partnership personnel submitted five call-out boxes (or sidebars) based on PCOR Partnership project experiences for possible inclusion in this BPM.

PCOR Partnership personnel participated in the kickoff conference call for the DOE Carbon Storage Systems and Well Management Systems BPM on May 20, 2015, as well as follow-up conference calls. PCOR Partnership experience related to the BPM was shared as seed lessons learned. Participants reviewed and provided first-pass comments related to the technical content of the 2013 revision of the BPM. Suggested changes to the outline were provided. The final draft outline with compiled DOE RCSP team comments was submitted to DOE on July 10, 2015. The scope of the BPM has changed to cover drilling and operations activities and will result in a different title when it is complete.

PCOR Partnership personnel participated in Webinars and conference calls for the DOE Risk Analysis and Simulation for Geologic Storage of CO_2 BPM, which was last updated in 2013. PCOR Partnership participants supplied five best practice/case histories to the working group for

discussion, along with comments on the document's overall outline. Comments on the outline were provided in the updated document and uploaded to the EDX workspace.

Task 10 – Site Closure

This task was not active in BP4, PY7.

Task 11 – Postinjection Monitoring and Modeling

This task was not active in BP4, PY7.

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. Effective March 18, 2015, Loreal Heebink assumed the task leader responsibilities.

Activities and Results

Accomplishments during BP4, PY8 (October 1, 2014 – September 30, 2015) include the following.

An assessment was conducted for the tasks during the period October 1, 2013 – September 30, 2014. A project assessment annual report (D57) was submitted on December 30, 2014.

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, PY8 (October 1, 2014 – September 30, 2015) include the following.

Progress Reports

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

addition, monthly progress reports are submitted to the DOE NETL project manager shortly after month end and are also posted on the partners-only Web site. Informal weekly updates are e-mailed to the DOE NETL project manager.

DOE Contract (DE-FC26-05NT42592) Modifications

During PY8, three modifications to the contract were issued.

The EERC received DOE Cooperative Agreement Amendment 31 effective December 1, 2014. The amendment authorized the following:

- Increased the total estimated amount of the award by $799,316 (and increased EERC cost share to a minimum of 37.38%) because of a cost overrun for work under Subtask 4.3.2 and a modified scope of work.

The EERC received DOE Cooperative Agreement Amendment 32 effective February 6, 2015. The amendment authorized the following:

- Obligated DOE funds in the amount of $499,316, bringing the total DOE obligation to $90,953,751, and fully funds the award for all budget periods.

The EERC received DOE Cooperative Agreement Amendment 33 effective September 25, 2015. The amendment authorized the following:

- Extended the BP4 (the current BP) end date by 6 months, from September 30, 2015, to March 31, 2016.

- Increased the total estimated amount of the award by $6,482,500 (and decreased EERC cost share to 36.96%) to allow the PCOR Partnership to expand upon the MVA program in accordance with the approved Tasks 3, 9, and 13, as outlined in the revised statement of project objectives (SOPO).

- Obligated the above DOE funds, bringing the total DOE obligation to $95,453,751, and fully funds the award for all budget periods.

- Replaced the SOPO with a revised SOPO as follows:
  - Changed D76 from a BPM to a regional regulatory perspective document.

  - Updated the list of MVA activities, and add D104 (Analysis of Expanded Seismic Campaign) due November 2016.

  - Modified terminology.

  - Added Subtask 9.1.4 – Life Cycle Assessments. Add D105 (Comparison of Non-EOR and EOR Life Cycle Assessments) due October 2016.

- Added D102 (Best Practices Manual – Adaptive Management Approach) with a revised due date of August 2016.

- Added D103 (Best Practices Manual – Programmatic Risk Management).

- Changed D58 (Quarterly Report – Progress) to D58/59 (Quarterly Technical Progress Report) to reflect the title currently used, and remove D59 (Quarterly Report – Milestones).

Project Management Plan

Revisions to the plan are under way and will be submitted in PY9 following the submission of the BP5 continuation application.

Annual Meetings

Regular project meetings (annual or as otherwise directed) will be held to ensure that project management and PCOR Partnership partner goals are being met. During PY8, the 13th partner meeting (the 12th meeting that included project results) was held.

The 2015 PCOR Partnership Annual Membership Meeting was held September 16 and 17, 2015, in Chicago, Illinois, and a CO_2 EOR Workshop was held prior to the meeting on September 15, 2015. The workshop and meeting attracted 71 attendees representing 40 organizations from 13 states, the District of Columbia, and two Canadian provinces and provided an overview of CO_2 management on a regional level in the upper Great Plains of North America, including recent program accomplishments, storage strategies and technologies, regulatory developments, and carbon storage infrastructure (Figure 17). The meeting also provided summaries of the PCOR Partnership's completed and ongoing activities. The presentations from the meeting and workshop are now available in the Products Database of the Partners-Only Web site. As shown in Table 12, the PCOR Partnership still garners significant interest from its varied members.

RCSP Support

- The PCOR Partnership was asked to coordinate the RCSP WWG. This task began in January 2009 and is ongoing through 2017.

- Members of the OWG and WWG took part in scheduled conference calls.

- A document outlining the PCOR Partnership's technical and nontechnical accomplishments throughout all phases (Phases I–III) was prepared by request from DOE for inclusion in a document it is creating on the accomplishments of the entire RCSP Program.

Figure 17. Attendees at the PCOR Partnership 2015 Annual Membership Meeting held September 16 and 17, 2015, in Chicago, Illinois.

Table 12. Participation Numbers, Including the Average, from the Past Seven Annual Meetings

Year	2009	2010	2011	2012	2013	2014	2015	Average
Attendees	84	74	83	84	88	86	71	81
Organizations	50	45	42	51	46	52	40	47
U.S. States	14	15	12	15	15	14	13	14
District of Columbia	Y	Y	Y	Y	Y	Y	Y	Y
Canadian Provinces	5	4	4	4	3	3	2	4
Other Foreign Countries	Sweden			England				

- PCOR Partnership personnel attended regional partnership annual meetings, including the 2014 Midwest Carbon Sequestration Science Conference in Champaign, Illinois, November 4–6, 2014, and the Midwest Regional Carbon Sequestration Partnership meeting hosted by Battelle in Columbus, Ohio, November 18, 2014.

- On October 14–15, 2014, PCOR Partnership personnel attended the Executive Roundtable "Commercial and Financial Structuring of Commercial-Scale Projects with Carbon Capture and Sequestration" in Washington, D.C.

- On November 10–11, 2014, project personnel presented at the Asia–Pacific Economic Cooperation (APEC) Expert Workshops on CCUS–EOR in Beijing, China. The presentations included "Lessons from Integrated Carbon Capture, Utilization, and Storage" and "Overview of Carbon Dioxide Enhanced Oil Recovery (EOR)."

- On March 26–27, 2015, the PCOR Partnership PI attended the International Forum on Recent Developments of CCS Implementation (http://co2quest.eu/ccsforum15.htm) in Athens, Greece, and presented "The Plains CO_2 Reduction Partnership—Demonstrating Carbon Dioxide Storage in the United States and Canada."

- On April 16, 2015, an EERC staff member attended and presented at the Workshop on CCS–EOR Utilization and Storage hosted by the Global Carbon Capture and Storage Institute in Beijing, China. "The Plains CO_2 Reduction (PCOR) Partnership EOR and Storage Demonstration Projects" was presented.

- On May 11–12, 2015, the PCOR Partnership PI attended and presented at the 10th Anniversary CO_2 GeoNet Open Forum in Venice, Italy. Three presentations were given: "An Adaptive Management Approach to CO_2 Storage Projects," "PCOR Partnership Outreach—Over a Decade of Activity," and "Implementing Carbon Capture and Storage—An Overview of the Plains CO_2 Reduction Partnership." While at the meeting, the PCOR Partnership PI spoke with a representative from the Midwest Geological Sequestration Consortium (MGSC) at the forum regarding the potential to have a PCOR Partnership–MGSC collaborative technical meeting.

- The PCOR Partnership PI attended the U.S.–Norway data-sharing workshop/meeting on August 17, 2015, in Pittsburgh, Pennsylvania.

- On August 24–28, 2015, an EERC staff member attended the China Inaugural Clean Coal Initiative meeting Billings, Montana.

National Risk Assessment Partnership

The National Risk Assessment Partnership (NRAP)—an initiative within DOE's Office of Fossil Energy and led by NETL—applies DOE's core competency in science-based prediction for engineered–natural systems to the long-term storage of CO_2. The science-based prediction of engineered–natural systems is a core competency that crosscuts many of today's energy challenges. Over decades, DOE has built a unique set of resources for predicting how these complex and heterogeneous systems behave under extreme conditions and over large ranges in time. NRAP has joined international efforts to develop the risk assessment tools needed for safe, permanent geologic CO_2 storage. NRAP members include five national DOE laboratories that have been conducting collaborative research for the Office of Fossil Energy's Carbon Sequestration Program for many years. The NRAP Program receives input from industry, government, nongovernment organizations, and academia regarding research needs for large-scale CO_2 storage deployment. The NRAP collaborative also keeps abreast of international developments by participating in collaborations like the IEAGHG Risk Assessment Network (25).

In PY8, the PCOR Partnership provided input to NRAP as follows:

- Attended the NRAP Stakeholders Meeting in Pittsburgh, Pennsylvania, August 20–21, 2015.

- Internally discussed the potential role of the PCOR Partnership in beta-testing various NRAP tools beginning in PY9.

Annual Carbon Capture and Sequestration Conference

Four staff members attended CCUS-14, sponsored by ExchangeMonitor Publications & Forums, held April 28 – May 1, 2015, in Pittsburgh, Pennsylvania. The following presentations were given.

- "Implementing Carbon Capture and Storage—An Overview of the Plains CO_2 Reduction Partnership"

- "Geologic Modeling and Simulation at the Aquistore Site—A Guide to MVA Deployment"

- "Technical Interpretation of the Transition of CO_2 EOR to Geologic Storage"

Annual Review Meeting

Eight staff members attended and presented at the DOE Carbon Storage Project Review Meeting held August 18–20, 2015, in Pittsburgh, Pennsylvania. One oral presentation was given in the plenary session focused on Bell Creek, and five posters were presented covering the work performed by the PCOR Partnership for Aquistore history matching, outreach, the Fort Nelson BPM, the WWG, and laboratory minimum miscibility testing. A booth backdrop was created for the conference that included PCOR Partnership materials.

GHGT-12

The GHGT conference series was formed in 1997 following the merger of the earlier series of the International Conference on Carbon Dioxide Removal and the Greenhouse Gas: Mitigation Options Conference. IEAGHG is the guardian of the conference series. The GHGT conferences are held every 2 years in IEAGHG member countries. The conference series rotates between North America, Europe, and Asia.

The GHGT conference series has established itself as the principal international conference on GHG mitigation technologies, especially CCS. Each conference is a forum for technical discussions related to the field of GHG control technology. This field can be defined, broadly, as technologies that allow us to continue using our large fossil energy reserves while reducing their associated GHG emissions.

The PCOR Partnership gave six oral presentations and four poster presentations at the conference held October 5–9, 2014, in Austin, Texas. The following presentations were given and published in the conference proceedings in *Energy Procedia* (v. 63):

- Oral presentations:
  - "A Rapid Method for Determining CO_2–Oil MMP and Visual Observations of CO_2–Oil Interactions at Reservoir Conditions"
  - "Application of Canadian Standards Association Guidelines for Geologic Storage of CO_2 Toward the Development of a Monitoring, Verification, and Accounting Plan for a Potential CCS Project at Fort Nelson, British Columbia, Canada"
  - "A Workflow to Determine CO_2 Storage in Deep Saline Formations"
  - "Digital Communications: Status and Potential Applications for CCUS Public Outreach" (via OWG)
  - "Guidance for States and Provinces on Operational and Postoperational Liability in the Regulation of Carbon Geologic Storage"
  - "The Nexus of Water and CCS: A Regional Carbon Sequestration Partnership Perspective"
- Poster presentations:
  - "Evaluation of Large-Scale Carbon Dioxide Storage Potential in the Basal Saline System in the Alberta and Williston Basins in North America"
  - "Characterization and Time-Lapse Monitoring Utilizing Pulsed-Neutron Well Logging—Associated CO_2 Storage at a Commercial CO_2 EOR Project"
  - "A Regional Wellbore Evaluation of the Basal Cambrian System"
  - "Model Development of the Aquistore CO_2 Storage Project"

In addition, the PCOR Partnership program manager chaired several sessions at the conference (Figure 18), including Session 8E, CCS and Water Use, and Session 9B, Geomechanics.

PCOR Partnership Partners

The PCOR Partnership has significant support and participation from its partners. As of September 30, 2015, almost 100 partners are supporting Phase III activities.

Figure 18. Charles Gorecki (third from left) participating in a regional partnerships panel discussion at GHGT-12 in Austin, Texas.

Task Leader Meetings

Approximately once a month, internal EERC meetings are held with all task leaders, the 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.

Carbon Sequestration Leadership Forum

The Carbon Sequestration Leadership Forum (CSLF) promotes collaborative research, development, and demonstration projects that reflect member priorities. CSLF may recognize collaborative projects that 1) facilitate the development of improved, cost-effective technologies for the separation and capture of CO_2 for transport and long-term, safe storage; 2) make these technologies broadly available internationally; and 3) identify and address wider issues relating to CCS. The RCSP project, comprising the seven regional partnerships including the PCOR Partnership, was recognized by CSLF at its Berlin meeting in September 2005.

The PCOR Partnership's Fort Nelson CCS project was granted CSLF recognition in October 2009 and is one of 43 such projects formally recognized. The PCOR Partnership has received

project recognition for not only one project, but two projects. The Zama Acid Gas EOR, CO_2 Storage, and Monitoring Project also received recognition in 2007.

In September 2014, DOE, on behalf of CSLF, requested updated information to track progress in the development of technologies that will assist in CCS development for the CSLF Technology Roadmap. A response was sent in October 2014.

"Lessons Learned from Enhanced Oil Recovery Operations—The Plains CO_2 Reduction Partnership" was presented at the 2015 CSLF Technology Workshop in Regina, Saskatchewan.

Also in PY9, efforts will continue to encourage Denbury to seek recognition of the Bell Creek project.

Advisory Board Meetings

In September 2011, DOE issued a contract modification, No. 21, authorizing the creation of an advisory board under SOPO Task 13 – Project Management. DOE also agreed to fund meetings and associated expenses through September 30, 2015.

The inaugural TAB meeting was held in February 2012 in San Diego, California. The first TAB includes the following CCUS and EOR experts:

- Bill Jackson, BillyJack Consulting, Inc. (Chair)
- Stefan Bachu, AITF
- Ray Hattenbach, Blue Strategies
- Lynn Helms, NDIC
- Mike Jones, Lignite Energy Council
- Steve Melzer, Melzer Consulting
- Tom Olle, Texas International Energy Partners
- Steve Whittaker, Global CCS Institute
- Neil Wildgust, PTRC

The fourth annual TAB meeting was scheduled and held March 3–5, 2015, in Phoenix, Arizona, with eight of the nine members present. Several presentations were given to update the TAB on the most recent status of the PCOR Partnership's projects. Topics covered included Bell Creek and Aquistore project updates, transition from CO_2 EOR to CO_2 storage, the D22 documentary, BPMs, the PCOR Partnership Atlas, and value-added reports.

In addition, technical WebEx meetings continued in PY8. This format was preferable to the TAB members to accommodate their busy travel schedules. In June 2015, TAB members participated in a WebEx discussion of the transition of CO_2 EOR to CO_2 storage. TAB members provided a great deal of feedback regarding this issue and gave suggestions for areas needing further research. Potential journal article ideas were also discussed.

A brief TAB meeting was also held in conjunction with the PCOR Partnership Annual Membership Meeting on September 15, 2015, in Chicago, Illinois. The required quorum of five appointed members (one by proxy) was met for this meeting.

Task 14 – RCSP WWG 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 the RCSP WWG comprising appropriate stakeholders. The RCSP WWG was initiated in January 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 BP4, PY8 (October 1, 2014 – September 30, 2015) include the following.

Monthly Conference Calls

A total of 64 monthly conference calls (M23) have taken place since the inception of this task, nine of which were completed in PY8, as follows: October 28, 2014; November 25, 2014; January 27, 2015 (WebEx meeting); February 26, 2015; March 25, 2015; April 28, 2015; May 28, 2015; June 23, 2015; and September 30, 2015. DOE NETL waived the requirement for conference calls during the months of December 2013, 2014, 2015, and 2016 as well as August 2013, July 2015, and August 2015. The July 2015 call was waived because of unavailability of participants, and the August 2015 call was waived because of the scheduled WWG Annual Meeting that same month. Minutes of the calls are submitted to the WWG members in the month following a call.

Status of the WWG

The WWG has completed the following activities:

- Produced a white paper that identified a wide variety of nexus of water and CCS issues, provided a comprehensive review of related processes and concepts, and began identifying the various challenges and opportunities.

- Created a mission statement:

  "The mission of the RSCP WWG is to provide a resource of knowledge, insight, and guidance to stakeholders involved with water and water resources and their relationship to the developing technology of CCS."

- Developed a water and CCS fact sheet (Fact Sheet No. 1; 2011) and general PowerPoint presentation that summarized work in the white paper. In March 2013, Fact Sheet No. 2

entitled “Carbon Capture and Storage: Protecting Freshwater Resources” was finalized. Fact Sheet No. 3, “Monitoring, Verification, and Accounting Plans for Protection of Water Resources During the Geologic Storage of Carbon Dioxide” was finalized October 31, 2013. In November 2014, Fact Sheet No. 4 entitled “Long-Term Protection of Freshwater Resources Following CO_2 Storage” was finalized. These products provide public outreach for the WWG and are distributed/presented at several conferences throughout the year.

- Developed a technologies gap assessment document (2011).

Annual Meetings

The seventh annual WWG meeting (M24) was held on August 18, 2015, in Pittsburgh, Pennsylvania, prior to the DOE Carbon Storage R&D Project Review Meeting. There were 11 attendees, including representation from four of the partnerships. The meeting agenda focused on the development of the WWG BPM and its relation to the DOE BPMs being developed.

NETL will provide finalized outlines for each of the DOE BPMs to the WWG members. A list of candidate topics for potential inclusion in the DOE BPMs will be developed. The WWG will work with the DOE BPM authors to incorporate water-related case studies as needed.

Fact Sheet Development

In December 2011, the WWG distributed a stakeholder group outreach survey. The results of the survey were compiled into a WWG interest inventory. The primary vehicle to address the WWG survey results is through the development of fact sheets. In September 2012, a new deliverable, D99 – Water–CCS Nexus-Related Fact Sheet, was created. The WWG then determined the topics for three fact sheets.

In November 2014, a fact sheet entitled “Long-Term Protection of Freshwater Resources Following CO_2 Storage” was finalized (26). This 2-page fact sheet identifies the primary physical and chemical mechanisms that are being relied upon to ensure the long-term containment of CO_2 in a storage reservoir following injection. The fact sheet is available on the PCOR Partnership public Web site at http://undeerc.org/pcor/newsandpubs/pdf/FSWWG4-Long-Term-Projection-Freshwater-Resources-Following-CO2-Storage.pdf.

Web Site Content Development

In order to more effectively engage stakeholder groups and address stakeholder concerns, the WWG has prepared the content for a Web site that is hosted on NETL’s existing Web site as one of the programs featured within the set of Web pages that describe the Carbon Storage Program (Figure 19). In PY8, DOE NETL officially released the WWG Web site (www.netl.doe.gov/research/coal/carbon-storage/wwg). The content generated by the WWG will be periodically updated and formally reported as part of the scheduled update due the end of May 2016 (PY9). Key Logic Systems, a NETL contractor, will apply the updates to the Web site.

Figure 19. A screenshot of the WWG home page, hosted on the NETL Web server (www.netl.doe.gov/research/coal/carbon-storage/wwg).

The Web site content was updated in PY8 to include the RCSP WWG presentation presented at the RCSP WWG Annual Meeting on August 18, 2015. The content of the Web site was reviewed, and other appropriate changes were applied.

Best Practices Manual

A BPM (D80) on the nexus of water and carbon storage activities was scheduled to be completed November 2016. This report would have highlighted the findings of the WWG and identified opportunities for water resource optimization in CCUS and topic areas where additional research could be conducted. An outline and draft text of the various sections and potential references was assembled and provided to the WWG.

Permission was received to drop the "BPM" title from D80 because of a lack of research leading to "best practices" in the field of water and CCS. The WWG group consensus was that the deliverable of a specific WWG BPM would be largely redundant of the efforts of DOE to refresh the CCS BPMs and that the efforts should be redirected. Partnership representatives will work with DOE BPM authors to incorporate water-related case studies as needed. The BPM subtask was stopped September 30, 2015, and D80 was deleted. It will be replaced with the production of the materials for a special issue of the *International Journal of Greenhouse Gas Control* (IJGGC) (see below), which was initiated prior to the consensus on the BPM.

Special Issue of the *International Journal of Greenhouse Gas Control*

The WWG is leading the effort to create and edit a special issue of IJGGC focused on the issues at the nexus of water and CCS. This subtask will result in production of all the materials necessary for Elsevier B.V. to publish the special issue (D106). On June 15, 2015, the formal announcement of the Special Issue on the "Nexus of Water and Carbon Capture and Storage" was distributed to various stakeholders. Abstracts were due July 17, 2015. Instructions to authors responding to the abstract call were sent. Development of a draft journal article on behalf of the WWG was initiated.

Additional Conference/Meeting Participation

- Attended and presented "The Nexus of Water and CCS: An RCSP Perspective" at GHGT-12 in Austin, Texas (paper available at www.sciencedirect.com; citation for the paper is listed in the Phase III Products section, by author, under Conference Papers).

- On December 15–18, 2014, attended the American Geophysical Union (AGU) Fall Conference on behalf of the WWG in San Francisco, California.

- Attended and presented at a DOE-sponsored workshop held at Lawrence Livermore National Library on March 16, 2015. The focus of the workshop was extracted-water projects associated with CCS.

- Prepared a poster entitled "Long-Term Protection of Freshwater Resources," presented at the DOE Carbon Storage R&D Project Review Meeting in Pittsburgh, Pennsylvania, August 18–

20, 2015, and attended the meeting. The abstract focuses on the last fact sheet developed by the WWG on the subject of long-term protection of freshwater resources.

Task 15 – 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 furtherance of the work that was performed in the Zama oil field during Phase II. A new deliverable was added for this new work (D86), an updated regional technology implementation plan for the Zama project, which was completed in February 2014. This task is now complete.

Activities and Results

The task concluded in BP4, PY7 (February 28, 2014).

Task 16 – Basal Cambrian System Characterization

As part of the ongoing effort to characterize the northern Great Plains region of North America, a multiyear project was performed, with a goal of determining the potential for geologic storage of CO_2 in rock formations of the Basal Cambrian system. This sequence of saline formations is continuous throughout much of the PCOR Partnership region and underlies many of the area's large point sources of CO_2. The Basal Cambrian system represents a regionally significant target for CCS but is an area that had not previously been systematically evaluated with respect to CO_2 storage resource.

Because the Basal Cambrian system occurs in large parts of both the United States and Canada, this project was conducted by the EERC in cooperation with AITF as a binational effort. The EERC worked closely with key partners in the United States to evaluate the American portion of the Basal Cambrian system. AITF led a multiprovince team to conduct a similar evaluation for the Canadian portion of this system.

This task was completed in March 2014.

Activities and Results

The task concluded in BP4, PY7 (March 31, 2014).

COST STATUS

The currently approved budget for Phase III is shown in Table 13.

Table 13. PCOR Partnership Phase III Budget as of Modification 33

	BP3 Year 1–Year 2 10/1/07 – 9/30/09		BP4 Year 3–Year 8.5 10/1/09 – 3/31/16		BP5 Year 8.5–Year 10 4/1/16 – 9/30/17		Total	
DOE Share	$4,209,149	54.59%	$65,123,437	63.04%	$9,668,307	80.00%	$79,000,893	64.18%
Nonfederal Cost Share								
Cash*	$887,428		$2,411,971		$0		$3,299,399	
In-Kind	$2,613,890		$35,766,276		$2,417,076		$40,797,242	
Total Nonfederal Cost Share	$3,501,318	45.41%	$38,178,247	36.96%	$2,417,076	20.00%	$44,096,641	35.82%
Total	**$7,710,467**	**100.00%**	**$103,301,684**	**100.00%**	**$12,085,383**	**100.00%**	**$123,097,534**	**100.00%**

* Cash as recognized by DOE.

On September 30, 2015, the PCOR Partnership completed its eighth year of BP4 activities (PY8, October 1, 2014 – September 30, 2015). Actual cash expenditures of DOE and nonfederal sources as well as noncash cost share reported through September 30, 2015, are listed in Table 14.

Table 14. BP4 Funding and Actual Costs as of September 30, 2015

Organization	Approved Budget,* $	Actual Costs Incurred, $
DOE Share – Cash	65,123,437	56,004,764
Nonfederal Share – Cash	2,411,971	2,995,751
Nonfederal Share – In-Kind	35,766,276	34,228,295
Total	103,301,684	93,228,810

*As of Modification No. 33.

SCHEDULE STATUS

Table 15 contains all of the Phase III deliverables, milestones, and submission dates for the reporting period. Tables 16–18 provide Gantt charts for BP4, including the reporting period (BP4, PY8) and the next program year.

Table 15. PCOR Partnership Phase III, BP3 and BP4 (through 9/30/2015) Deliverables and Milestones

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 15. PCOR Partnership Phase III, BP3 and BP4 (through 9/30/2015) Deliverables and Milestones (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 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	Not applicable	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 15. PCOR Partnership Phase III, BP3 and BP4 (through 9/30/2015) Deliverables and Milestones (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
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

Continued…

Table 15. PCOR Partnership Phase III, BP3 and BP4 (through 9/30/2015) Deliverables and Milestones (continued)

Title/Description	Due Date	Actual Completion Date
Year 4 – Quarter 1 (October–December 2010)		
D87: Task 4 – Bell Creek Test Site – Geomechanical Experimental Design Package	10/30/10	10/29/10
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	10/31/10	10/29/10
M23: Task 14 – Monthly WWG Conference Call Held	10/31/10	10/26/10
M23: Task 14 – Monthly WWG Conference Call Held	11/30/10	Waived by DOE
D57: Task 12 – Project Assessment Annual Report	12/31/10	12/23/10
M23: Task 14 – Monthly WWG Conference Call Held	12/31/10	12/13/10
Year 4 – Quarter 2 (January–March 2011)		
M8: Task 4 – Bell Creek Test Site Wellbore Leakage Data Collection Initiated	1/15/11	1/14/11
D31: Task 4 – Bell Creek Test Site – Geological Characterization Experimental Design Package	1/31/11	1/27/11
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	1/31/11	1/31/11
M23: Task 14 – Monthly WWG Conference Call Held	1/31/11	1/19/11
M28: Task 4 – Bell Creek Geological Experimental Design Package Completed	1/31/11	1/27/11
D15: Task 2 – Bell Creek Test Site Fact Sheet	2/28/11	2/28/11
M23: Task 14 – Monthly WWG Conference Call Held	2/28/11	Waived by DOE
D10: Task 1 – Demonstration Project Reporting System Update	3/31/11	3/25/11
D18: Task 2 – Bell Creek Test Site PowerPoint Presentation (update)	3/31/11	3/31/11
D26: Task 2 – Fort Nelson Test Site Poster	3/31/11	3/31/11
D28: Task 3 – Environmental Questionnaire – Bell Creek Test Site	3/31/11	3/30/11
D85: Task 6 – Report – Opportunities and Challenges Associated with CO_2 Compression and Transportation During CCS Activities	3/31/11	3/31/11
M23: Task 14 – Monthly WWG Conference Call Held	3/31/11	3/22/11
Year 4 – Quarter 3 (April–June 2011)		
M30: Task 5 – Bell Creek Test Site Baseline MVA Initiated	4/01/11	3/24/11
M23: Task 14 – Monthly WWG Conference Call Held	4/30/11	4/21/11
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	4/30/11	4/29/11
D88: Task 13 – Programmatic Risk Management Plan	4/30/11	4/29/11
D17: Task 2 – General Phase III Information PowerPoint Presentation (update)	5/31/11	5/31/11
D34: Task 4 – Bell Creek Test Site – Baseline Hydrogeological Final Report	5/31/11	5/31/11

Continued…

Table 15. PCOR Partnership Phase III, BP3 and BP4 (through 9/30/2015) Deliverables and Milestones (continued)

Title/Description	Due Date	Actual Completion Date
Year 4 – Quarter 3 (April–June 2011) (continued)		
M23: Task 14 – Monthly WWG Conference Call Held	5/31/11	5/5/11
D19: Task 2 – Fort Nelson Test Site PowerPoint Presentation (update)	6/30/11	6/30/11
M23: Task 14 – Monthly WWG Conference Call Held	6/30/11	6/23/11
M24: Task 14 – WWG Annual Meeting Held	6/30/11	5/5/11
Year 4 – Quarter 4 (July–September 2011)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	7/31/11	7/28/11
M23: Task 14 – Monthly WWG Conference Call Held	7/31/11	7/26/11
D29: Task 3 – Permitting Action Plan	8/31/11	8/31/11
D66: Task 9 – Bell Creek Test Site – Simulation Report	8/31/11	8/31/11
D67: Task 9 – Fort Nelson Test Site – Simulation Report	7/31/11	8/31/11
M23: Task 14 – Monthly WWG Conference Call Held	8/31/11	8/24/11
D1: Task 1 – Review of Source Attributes	9/30/11	9/21/11
D4: Task 1 – Permitting Review – Basic EPA Requirements[+]	9/30/11	9/30/11
D9: Task 1 – Updated DSS	9/30/11	9/23/11
D25: Task 2 – Bell Creek Test Site Poster	9/30/11	9/30/11
D50: Task 9 – Bell Creek Test Site – Site Characterization, Modeling, and Monitoring Plan	9/30/11	9/30/11
M23: Task 14 – Monthly WWG Conference Call Held	9/30/11	Waived by DOE
M31: Task 9 – Bell Creek Test Site – Site Characterization, Modeling, and Monitoring Plan Completed	9/30/11	9/30/11
M33: Task 16 – Basal Cambrian Baseline Geological Characterization Completed	9/30/11	9/29/11
Year 5 – Quarter 1 (October–December 2011)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	10/31/11	10/31/11
M23: Task 14 – Monthly WWG Conference Call Held	10/31/11	10/26/11
M23: Task 14 – Monthly WWG Conference Call Held	11/30/11	11/30/11
D57: Task 12 – Project Assessment Annual Report	12/31/11	12/30/11
M23: Task 14 – Monthly WWG Conference Call Held	12/31/11	Waived by DOE
M34: Task 16 – Basal Cambrian Static Geological Model Completed	12/31/11	12/21/11

Continued . . .

Table 15. PCOR Partnership Phase III, BP3 and BP4 (through 9/30/2015) Deliverables and Milestones (continued)

Title/Description	Due Date	Actual Completion Date
Year 5 – Quarter 2 (January–March 2012)		
M16: Task 4 – Bell Creek Test Site – Initiation of Production and Injection Simulation	1/13/12	12/29/11
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	1/31/12	1/31/12
D65: Task 4 – Fort Nelson Test Site – Site Characterization Report	1/31/12	1/31/12
D81: Task 1 – Regional Carbon Sequestration Atlas (update)	1/31/12	1/31/12
M23: Task 14 – Monthly WWG Conference Call Held	1/31/12	1/19/12
M29: Task 4 – Fort Nelson Site Characterization Report Completed	1/31/12	1/31/12
D91: Task 16 – Report – Geological Characterization of the Basal Cambrian System in the Williston Basin	2/29/12	2/29/12
M23: Task 14 – Monthly WWG Conference Call Held	2/29/12	2/28/12
D5: Task 1 – Second Target Area Completed	3/31/12	3/30/12
D18: Task 2 – Bell Creek Test Site PowerPoint Presentation (update)	3/31/12	3/30/12
M10: Task 4 – Bell Creek Test Site Wellbore Leakage Data Collection Completed	3/31/12	3/12/12
M36: Task 13 – Annual Advisory Board Scheduled	3/31/12	3/28/12
M23: Task 14 – Monthly WWG Conference Call Held	3/31/12	3/27/12
Year 5 – Quarter 3 (April–June 2012)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	4/30/12	4/30/12
M23: Task 14 – Monthly WWG Conference Call Held	4/30/12	Waived by DOE
D17: Task 2 – General Phase III Information PowerPoint Presentation (update)	5/31/12	5/31/12
M23: Task 14 – Monthly WWG Conference Call Held	5/31/12	5/31/12
D19: Task 2 – Fort Nelson Test Site PowerPoint Presentation (update)	6/30/12	6/29/12
D41: Task 4 – Fort Nelson Test Site – Geochemical Report	6/30/12	6/29/12
D84: Task 6 – Report – A Phased Approach to Building Pipeline Network for CO_2 Transportation During CCS	6/30/12	6/29/12
M23: Task 14 – Monthly WWG Conference Call Held	6/30/12	6/28/12
M24: Task 14 – WWG Annual Meeting Held	6/30/12	5/3/12
M32: Task 4 – Fort Nelson Geochemical Report Completed	6/30/12	6/29/12

Continued . . .

Table 15. PCOR Partnership Phase III, BP3 and BP4 (through 9/30/2015) Deliverables and Milestones (continued)

Title/Description	Due Date	Actual Completion Date
Year 5 – Quarter 4 (July–September 2012)		
D13: Task 2 – Public Site Updates	7/31/12	7/31/12
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	7/31/12	7/31/12
D67: Task 9 – Fort Nelson Test Site – Simulation Report	7/31/12	7/31/12
M23: Task 14 – Monthly WWG Conference Call Held	7/31/12	7/24/12
D66: Task 9 – Bell Creek Test Site – Simulation Report	8/31/12	8/31/12
M23: Task 14 – Monthly WWG Conference Call Held	8/31/12	8/30/12
D1: Task 1 – Review of Source Attributes	9/30/12	9/28/12
D10: Task 1 – DPRS Update	9/30/12	9/28/12
M23: Task 14 – Monthly WWG Conference Call Held	9/30/12	9/27/12
Year 6 – Quarter 1 (October–December 2012)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	10/31/12	10/31/12
M23: Task 14 – Monthly WWG Conference Call Held	10/31/12	10/25/12
M23: Task 14 – Monthly WWG Conference Call Held	11/30/12	11/28/12
D57: Task 12 – Project Assessment Annual Report	12/31/12	12/28/12
M23: Task 14 – Monthly WWG Conference Call Held	12/31/12	Waived by DOE
Year 6 – Quarter 2 (January–March 2013)		
D32: Task 4 – Bell Creek Test Site – Geomechanical Final Report	1/31/13	1/31/13
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	1/31/13	1/31/13
M23: Task 14 – Monthly WWG Conference Call Held	1/31/13	1/16/13
D14: Task 2 – General Phase III Fact Sheet (update)	2/28/13	2/28/13
M23: Task 14 – Monthly WWG Conference Call Held	2/28/13	2/28/13
D85: Task 6 – Report – Opportunities and Challenges Associated with CO_2 Compression and Transportation During CCS Activities	3/31/13	Waived by DOE (journal article)
D89: Task 16 – Report – Geochemical Evaluation of the Basal Cambrian System	3/31/13	3/28/13
D99: Task 14 – Water/CCS Nexus-Related Fact Sheet	3/31/13	3/22/13
M23: Task 14 – Monthly WWG Conference Call Held	3/31/13	3/28/13
M36: Task 13 – Annual Advisory Board Meeting Scheduled	3/31/13	3/27/13

Continued . . .

Table 15. PCOR Partnership Phase III, BP3 and BP4 (through 9/30/2015) Deliverables and Milestones (continued)

Title/Description	Due Date	Actual Completion Date
Year 6 – Quarter 3 (April–June 2013)		
D15: Task 2 – Bell Creek Test Site Fact Sheet (update)	4/15/13	3/25/13
D16: Task 2 – Fort Nelson Test Site Fact Sheet (update)	4/30/13	Waived by DOE
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	4/30/13	4/30/13
M14: Task 4 – Bell Creek Test Site Geological Characterization Data Collection Completed	4/30/13	4/30/13
M23: Task 14 – Monthly WWG Conference Call Held	4/30/13	4/25/13
M35: Task 16 – Basal Cambrian Dynamic Capacity Estimation Completed	4/30/13	4/30/13
D17: Task 2 – General Phase III Information PowerPoint Presentation (update)	5/31/13	5/31/13
D43: Task 5 – Bell Creek Test Site – Monitoring Experimental Design Package	5/31/13	5/31/13
M23: Task 14 – Monthly WWG Conference Call Held	5/31/13	5/30/13
M27: Task 5 – Bell Creek Test Site – MVA Equipment Installation and Baseline MVA Activities Completed	5/31/13	5/31/13
M23: Task 14 – Monthly WWG Conference Call Held	6/30/13	6/27/13
M26: Task 8 – Bell Creek Test Site – CO_2 Injection Initiated	6/30/13	May 2013 – sent 6/25/13
M37: Task 3 – IOGCC Task Force Subgroup Meeting 2 Held	5/9/13	5/29/13
M42: Task 3 – Findings and Recommendations of the Operational and Postoperational Subgroups Presented to the Carbon Geologic Storage (CGS) Task Force	6/30/13	6/20/13 – sent 6/28/13
Year 6 – Quarter 4 (July–September 2013)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	7/31/13	7/31/13
D33: Task 4 – Bell Creek Test Site – Geochemical Final Report	7/31/13	7/31/13
M12: Task 4 – Bell Creek Test Site Geochemical Work Completed	7/31/13	7/31/13
M23: Task 14 – Monthly WWG Conference Call Held	7/31/13	7/25/13
D64: Task 4 – Bell Creek Test Site – Site Characterization Report	8/31/13	8/29/13
D66: Task 9 – Bell Creek Test Site – Simulation Report	8/31/13	8/30/13
D81: Task 1 – Regional Carbon Sequestration Atlas (update)	8/31/13	5/1/13
M23: Task 14 – Monthly WWG Conference Call Held	8/31/13	Waived by DOE

Continued . . .

Table 15. PCOR Partnership Phase III, BP3 and BP4 (through 9/30/2015) Deliverables and Milestones (continued)

Title/Description	Due Date	Actual Completion Date
Year 6 – Quarter 4 (July–September 2013) (continued)		
D1: Task 1 – Review of Source Attributes	9/30/13	9/5/13
D6: Task 3 – Permitting Review – Update 1	9/30/13	9/24/13
D48: Task 7 – Bell Creek Test Site – Procurement Plan and Agreement Report	9/30/13	9/24/13
D90: Task 16 – Report – Wellbore Evaluation of the Basal Cambrian System	9/30/13	9/5/13
D94:Task 2 – Aquistore Project Fact Sheet	9/30/13	9/30/13
D95: Task 2 – Aquistore Project Poster	9/30/13	9/30/13
D98: Task 3 – Report – Findings, Recommendations, and Guidance of CGS Task Force	9/30/13	8/30/13
M23: Task 14 – Monthly WWG Conference Call Held	9/30/13	9/30/13
M38: Task 3 – IOGCC Task Force Wrap-Up Meeting Held	9/30/13	8/16/13 – sent 9/5/13
M39: Task 3 – IOGCC Task Force Editing Subgroup Meeting Held	9/30/13	6/3/13 – sent 9/5/13
M40: Task 15 – Further Characterization of the Zama Acid Gas EOR, CO_2 Storage, and Monitoring Project Completed	9/30/13	9/24/13
Year 7 – Quarter 1 (October–December 2013)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	10/31/13	10/31/13
D42: Task 5 – Bell Creek Test Site – Injection Experimental Design Package	10/31/13	10/30/13
D99: Task 14 – Water–CCS Nexus-Related Fact Sheet	10/31/13	10/31/13
M23: Task 14 – Monthly WWG Conference Call Held	10/31/13	10/31/13
M23: Task 14 – Monthly WWG Conference Call Held	11/30/13	11/21/13
M23: Task 14 – Monthly WWG Conference Call Held	12/31/13	Waived by DOE
M24: Task 14 – WWG Annual Meeting Held	12/31/13	8/19/13
M43: Task 9 – Bell Creek Test Site – First Full-Repeat Sampling of the Groundwater- Soil Gas-Monitoring Program Completed	12/31/13	11/15/13 – sent 12/13/13
Year 7 – Quarter 2 (January–March 2014)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	1/31/14	1/31/14
D57: Task 12 – Project Assessment Annual Report	1/31/14	1/31/14
M23: Task 14 – Monthly WWG Conference Call Held	1/31/14	1/28/14
M41: Task 6 – Decision to Incorporate Ramgen Compression Technology into Bell Creek Project	1/31/14	1/29/14

Continued . . .

Table 15. PCOR Partnership Phase III, BP3 and BP4 (through 9/30/2015) Deliverables and Milestones (continued)

Title/Description	Due Date	Actual Completion Date
Year 7 – Quarter 2 (January–March 2014) (continued)		
D86: Task 15 – Updated Regional Implementation Plan for Zama	2/28/14	2/28/14
M23: Task 14 – Monthly WWG Conference Call Held	2/28/14	2/27/14
D24: Task 2 – PCOR Partnership Region Sequestration General Poster (update)	3/31/14	3/27/14
D36: Task 4 – Bell Creek Test Site – Wellbore Leakage Final Report	3/31/14	3/19/14
D92: Task 16 – Report – Storage Capacity and Regional Implications for Large-Scale Storage in the Basal Cambrian System	3/31/14	3/27/14
D93: Task 1 – Geological Modeling and Simulation Report for the Aquistore Project	3/31/14	3/25/14
D96: Task 4 – Bell Creek Test Site – 3-D Seismic and Characterization Report	3/31/14	3/27/14
M23: Task 14 – Monthly WWG Conference Call Held	3/31/14	3/25/14
M36: Task 13 – Annual Advisory Board Meeting Scheduled	3/31/14	3/4/14 – sent 3/25/14
M44: Task 9 – Bell Creek Test Site – First 3-D VSP Repeat Surveys Completed	3/31/14	3/1/14 – sent 3/25/14
Year 7 – Quarter 3 (April–June 2014)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	4/30/14	4/30/14
M23: Task 14 – Monthly WWG Conference Call Held	4/30/14	4/24/14
D17: Task 2 – General Phase III Information PowerPoint Presentation (update)	5/31/14	5/30/14
D101: Task14 – WWG Web Site Content Update	5/31/14	5/30/14
M23: Task 14 – Monthly WWG Conference Call Held	5/31/14	5/21/14
D44: Task 5 – Bell Creek Test Site – Drilling and Completion Activities Report	6/30/14	5/30/14
M23: Task 14 – Monthly WWG Conference Call Held	6/30/14	6/26/14
M45: Task 9 – Bell Creek Test Site – First Full-Repeat of Pulsed Neutron Logging Campaign Completed	6/30/14	6/9/14
M46: Task 9 – Bell Creek Test Site – 1 Year of Injection Completed	6/30/14	6/26/14

Continued . . .

Table 15. PCOR Partnership Phase III, BP3 and BP4 (through 9/30/2015) Deliverables and Milestones (continued)

Title/Description	Due Date	Actual Completion Date
Year 7 – Quarter 4 (July–September 2014)		
D13: Task 2 – Public Site Updates	7/31/14	7/29/14
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	7/31/14	7/31/14
M23: Task 14 – Monthly WWG Conference Call Held	7/31/14	7/17/14 WebEx
D66: Task 9 – Bell Creek Test Site – Simulation Report	8/31/14	8/27/14 Exec. Sum.
M23: Task 14 – Monthly WWG Conference Call Held	8/31/14	Waived by DOE
D1: Task 1 – Review of Source Attributes	9/30/14	9/24/14
D7: Task 1 – Third Target Area Completed	9/30/14	9/26/14
D93: Task 1 – Geological Modeling and Simulation Report for the Aquistore Project	9/30/14	9/30/14
D100: Task 9 – Fort Nelson Test Site – Best Practices Manual – Feasibility Study	9/30/14	9/30/14
M23: Task 14 – Monthly WWG Conference Call Held	9/30/14	9/30/14
Year 8 – Quarter 1 (October–December 2014)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	10/31/14	10/31/14
D99: Task 14 – Water/CCS Nexus-Related Fact Sheet	10/31/14	10/31/14
M23: Task 14 – Monthly WWG Conference Call Held	10/31/14	10/28/14
M48: Task 9 – Bell Creek Test Site – 1 Million Metric Tons of CO_2 Injected	10/31/14	10/29/14
M23: Task 14 – Monthly WWG Conference Call Held	11/30/14	11/25/14
D57: Task 12 – Project Assessment Annual Report	12/31/14	12/30/14
M24: Task 14 – WWG Annual Meeting Held	12/31/14	8/11/14
Year 8 – Quarter 2 (January–March 2015)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	1/31/15	1/30/15
D32: Task 4 – Bell Creek Test Site – Geomechanical Report (Update 1)	1/31/15	1/28/15
M23: Task 14 – Monthly WWG Conference Call Held	1/31/15	1/27/15
M23: Task 14 – Monthly WWG Conference Call Held	2/28/15	2/26/15
D25: Task 2 – Bell Creek Test Site Poster (update)	3/31/15	2/5/15
M23: Task 14 – Monthly WWG Conference Call Held	3/31/15	3/25/15
M36: Task 13 – Annual Advisory Board Meeting Scheduled	3/31/15	3/31/15

Continued . . .

Table 15. PCOR Partnership Phase III, BP3 and BP4 (through 9/30/2015) Deliverables and Milestones (continued)

Title/Description	Due Date	Actual Completion Date
Year 8 – Quarter 3 (April–June 2015)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	4/30/15	4/29/15
M23: Task 14 – Monthly WWG Conference Call Held	4/30/15	4/28/15
D17: Task 2 – General Phase III Information PowerPoint Presentation (update)	5/31/15	6/1/15
M23: Task 14 – Monthly WWG Conference Call Held	5/30/15	5/28/15
D85: Task 6 – Report – Opportunities and Challenges Associated with CO_2 Compression and Transportation During CCUS (carbon capture, utilization, and storage) Activities (update)	5/31/15	5/29/15
M23: Task 14 – Monthly WWG Conference Call Held	6/30/15	6/23/15
M49: Task 9 – Bell Creek Test Site – 1.5 Million Metric Tons of CO_2 Injected	6/30/15	6/30/15
Year 8 – Quarter 4 (July–September 2015)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	7/31/15	7/31/15
M23: Task 14 – Monthly WWG Conference Call Held	7/31/15	Waived by DOE
M50: Task 9 – Bell Creek Test Site – 2 Years of Near-Surface Assurance Monitoring Completed	7/31/15	7/21/15
D66: Task 9 – Bell Creek Test Site – Simulation Report	8/31/15	8/27/15 Exec. Sum.
M23: Task 14 – Monthly WWG Conference Call Held	8/31/15	Waived by DOE
M51: Task 9 – Bell Creek Test Site – Initial Analysis for First Large-Scale Repeat Pulsed-Neutron Logging Campaign Post-Significant CO_2 Injection Completed	8/31/15	8/31/15
D1: Task 1 – Review of Source Attributes (update)	9/30/15	9/23/15
D8: Task 3 – Permitting Review – Update 2	9/30/15	9/30/15
D49: Task 8 – Bell Creek Test Site – Transportation and Injection Operations Report	7/31/15	9/29/15
M23: Task 14 – Monthly WWG Conference Call Held	9/30/15	9/30/15

Table 16. PCOR Partnership Phase III Gantt Chart (BP4, PY3–PY4)

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Table 16. PCOR Partnership Phase III Gantt Chart (BP4, PY3–PY4) (continued)

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Table 16. PCOR Partnership Phase III Gantt Chart (BP4, PY3–PY4) (continued)

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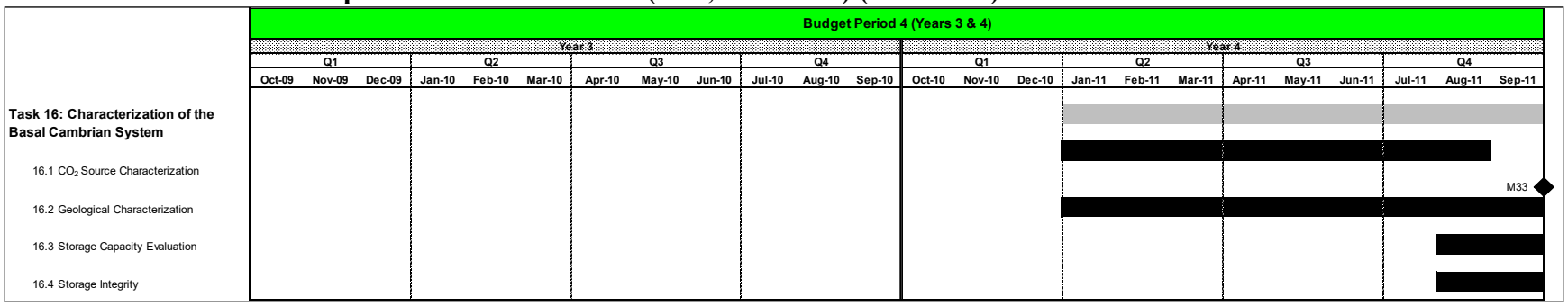
Table 16. PCOR Partnership Phase III Gantt Chart (BP4, PY3–PY4) (continued)



Summary Task | Activity Bar | Progress Activity Bar | Time Now | Deliverable | Milestone

Key for Deliverables (D)			
D1	Review of Source Attributes	D29	Permitting Action Plan
D4	Permitting Review – Basic EPA Requirements	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	D66	BC Test Site – Simulation Report
D18	BC Test Site PowerPoint Presentation	D67	FN Test Site – Simulation 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	D88	Programmatic Risk Management Plan

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
M30	BC Test Site – Baseline MVA Activities Initiated
M31	BC Test Site – Site Characterization, Modeling, and Monitoring Plan Completed
M33	Basal Cambrian Baseline Geological Characterization Completed

Table 17. PCOR Partnership Phase III Gantt Chart (BP4, PY5–PY6)

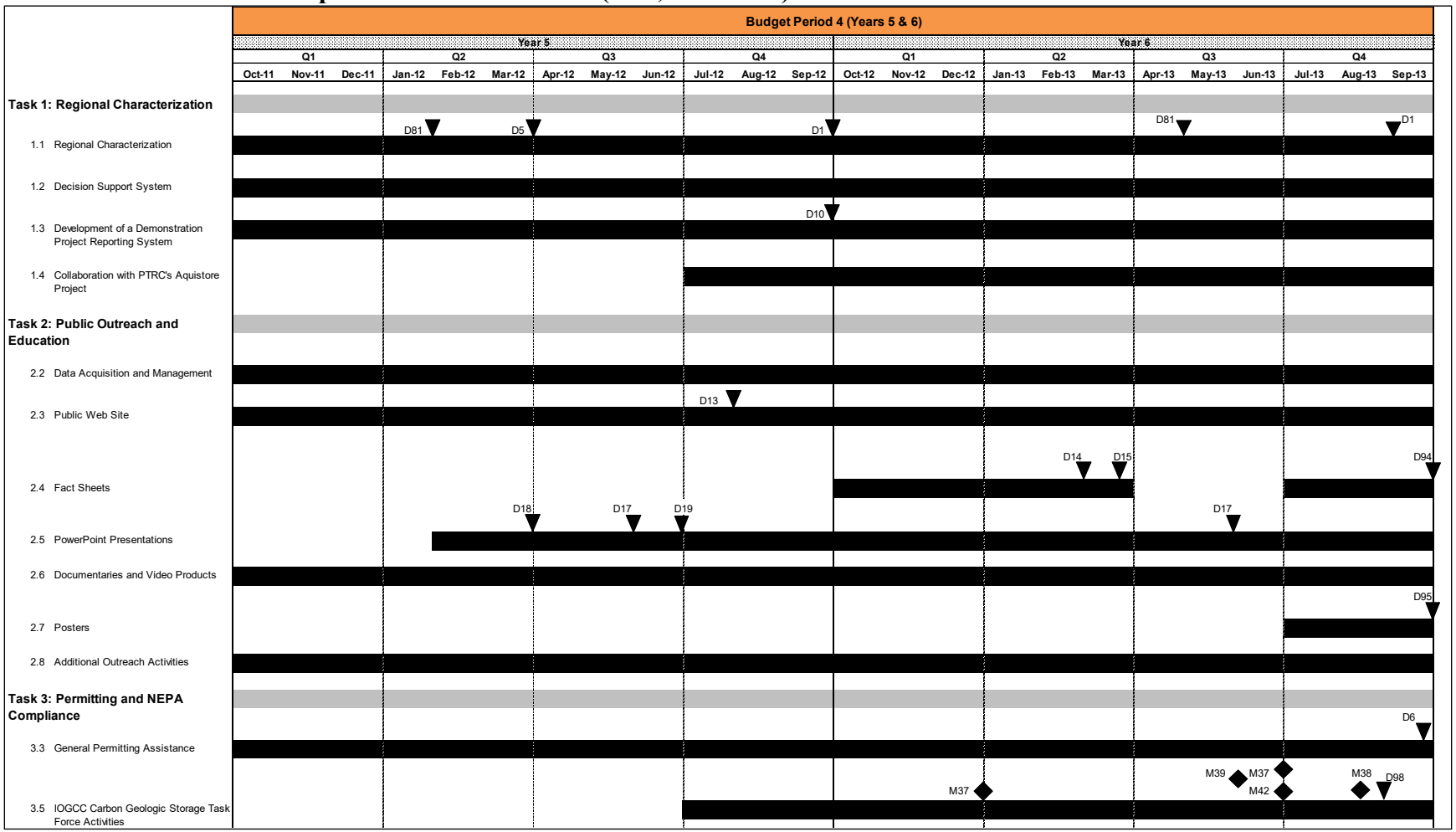


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Table 17. PCOR Partnership Phase III Gantt Chart (BP4, PY5–PY6) (continued)

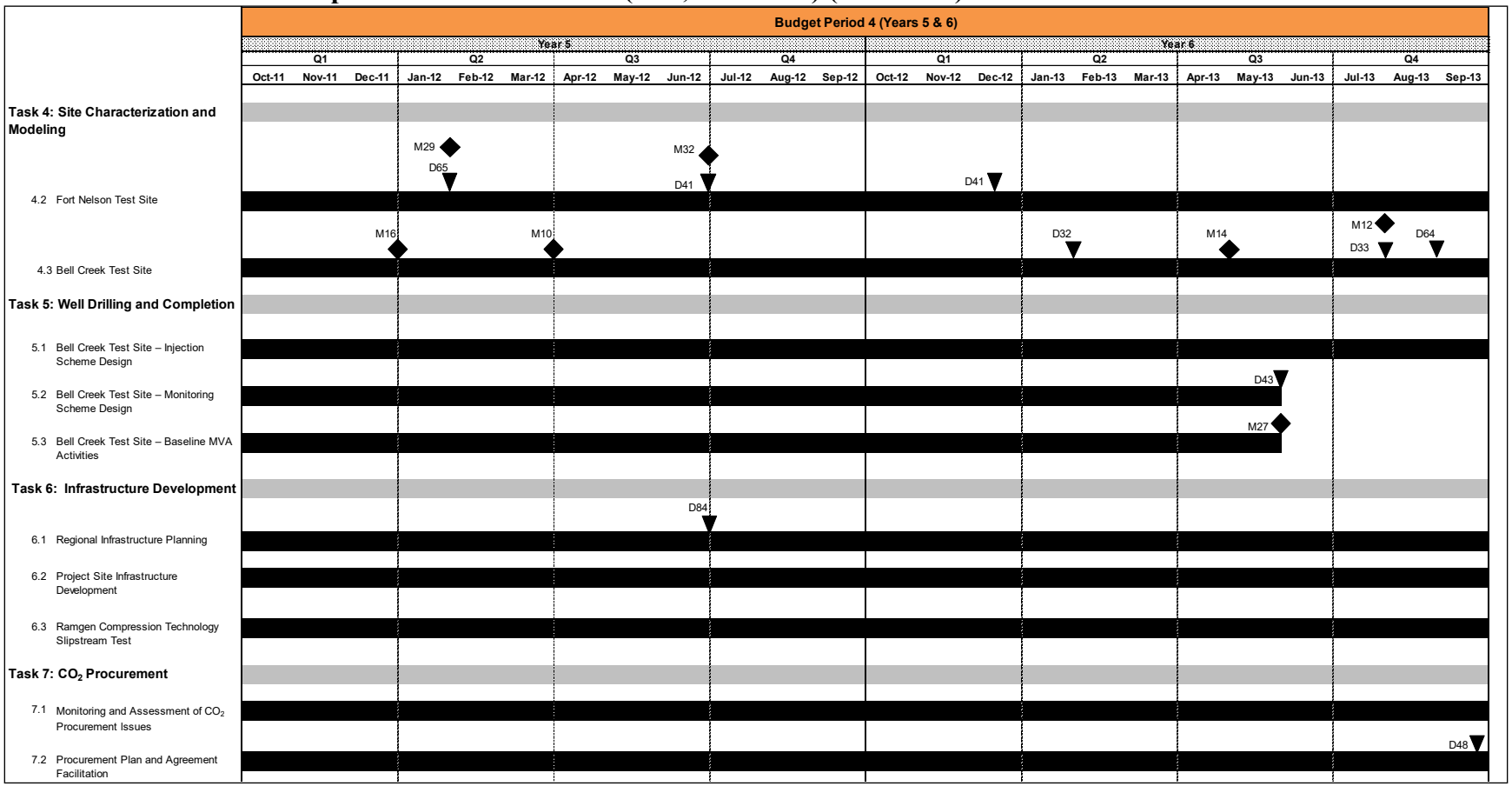

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Table 17. PCOR Partnership Phase III Gantt Chart (BP4, PY5–PY6) (continued)

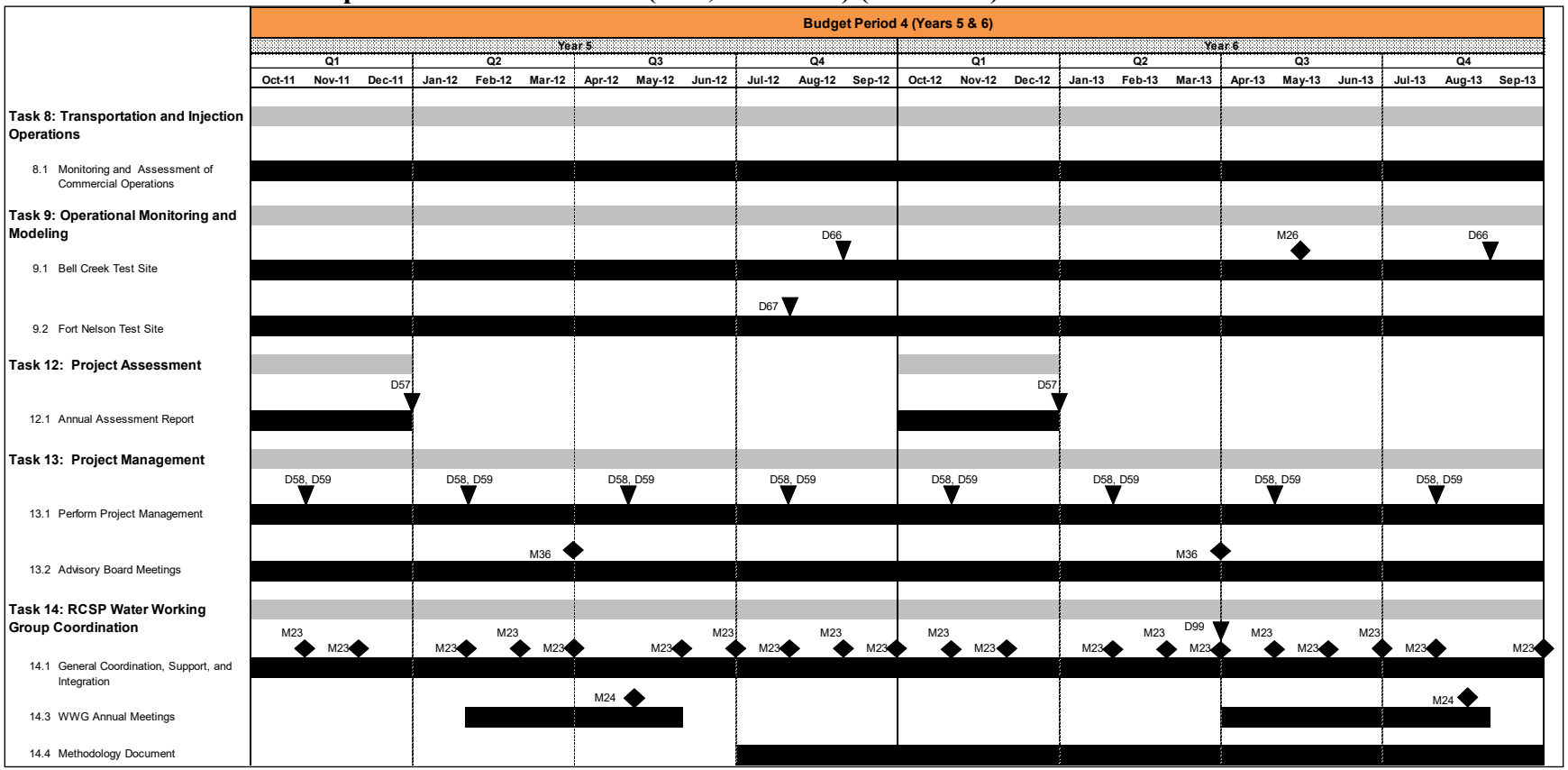

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Table 17. PCOR Partnership Phase III Gantt Chart (BP4, PY5–PY6) (continued)

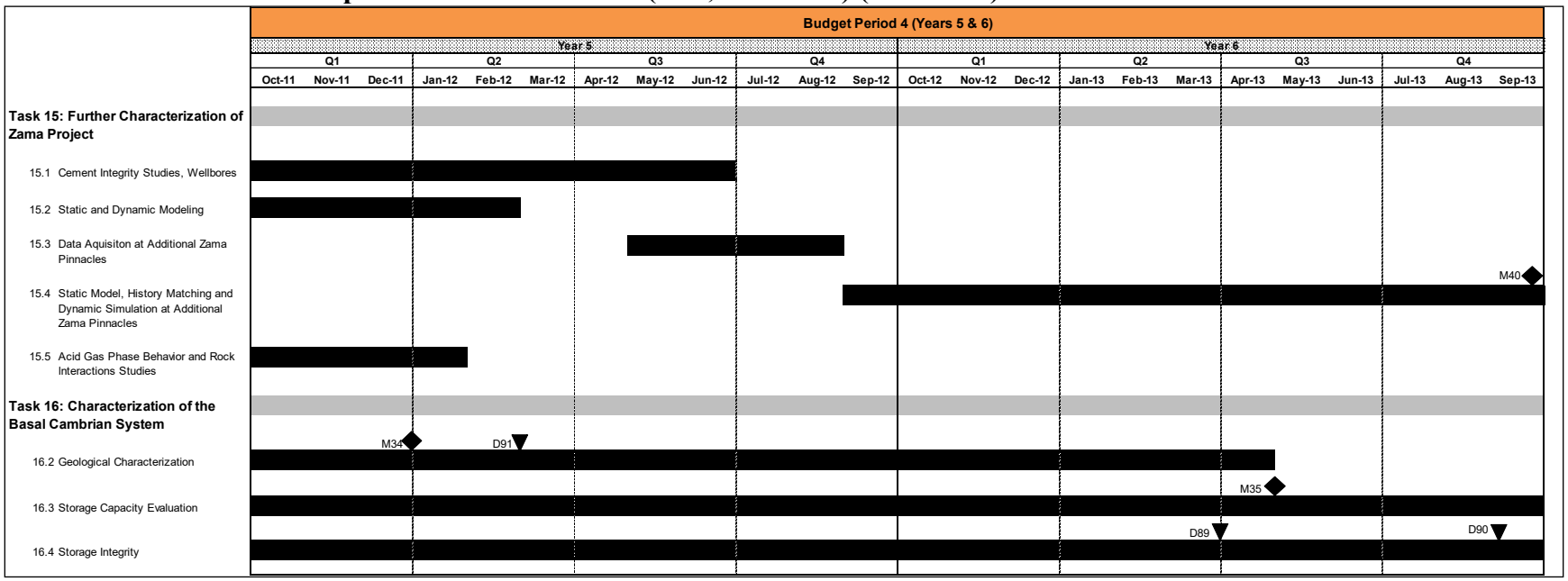

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Table 17. PCOR Partnership Phase III Gantt Chart (BP4, PY5–PY6) (continued)

Key for Deliverables (D) ▼				Key for Milestones (M) ◆	
D1	Review of Source Attributes	D52	FN Test Site – Site Characterization, Modeling, and Monitoring Plan	M8	BC Test Site – Wellbore Leakage Data Collection Initiated
D4	Permitting Review – Basic EPA Requirements	D57	Project Assessment Annual Report	M9	BC Test Site – Geological Model Development Initiated
D5	Second Target Area Completed	D58	Quarterly Progress Report	M10	BC Test Site – Wellbore Leakage Data Collection Completed
D6	Permitting Review – Update 1	D59	Milestone Quarterly Report	M12	BC Test Site – Preinjection Geochemical Work Completed
D9	Updated DSS	D64	BC Test Site – Site Characterization Report	M14	BC Test Site – Geological Characterization Data Collection Completed
D10	DPRS Update	D65	FN Test Site – Site Characterization Report	M16	BC Test Site – Initiation of Production and Injection Simulations
D11	Outreach Plan	D66	BC Test Site – Simulation Report	M23	Monthly WWG Conference Call Held
D13	Public Site Updates	D67	FN Test Site – Simulation Report	M24	WWG Annual Meeting Held
D14	General Phase III Fact Sheet	D78	White Paper – Nexus of CCS and Water	M26	BC Test Site – CO_2 Injection Initiated
D15	BC Test Site Fact Sheet	D81	Regional Carbon Sequestration Atlas	M27	BC Test Site – MVA Equipment Installation and Baseline MVA Activities Completed
D17	General Phase III Information PowerPoint Presentation	D84	Report – A Phased Approach to Building Pipeline Network for CO_2 Transportation During CCUS	M28	BC Test Site – Geological Characterization Experimental Design Package Completed
D18	BC Test Site PowerPoint Presentation			M29	FN Test Site – Site Characterization Report Completed
D19	FN Test Site PowerPoint Presentation	D85	Report – Opportunities and Challenges Associated with CO_2 Compression and Transportation During CCUS Activities	M30	BC Test Site – Baseline MVA Activities Initiated
D20	Video Support to PowerPoint and Web Site			M31	BC Test Site – Site Characterization, Modeling, and Monitoring Plan Completed
D24	PCOR Partnership Region CO_2 Storage General Poster	D87	BC Test Site – Geomechanical Experimental Design Package	M32	FN Test Site – Geochemical Report Completed
D25	BC Test Site Poster	D88	Programmatic Risk Assessment	M33	Basal Cambrian Baseline Geological Characterization Completed
D26	FN Test Site Poster	D89	Report – Geochemical Evaluation of the Basal Cambrian System	M34	Basal Cambrian Static Geological Model Completed
D28	BC Test Site – Environmental Questionnaire	D90	Report – Wellbore Evaluation of the Basal Cambrian System	M35	Basal Cambrian Dynamic Capacity Estimation Completed
D29	Permitting Action Plan	D91	Report – Geological Characterization of the Basal Cambrian System in the Williston Basin	M36	Annual Advisory Board Meeting Scheduled
D31	BC Test Site – Geological Characterization Experimental Design Package			M37	Subgroup Meetings Held
D32	BC Test Site – Geomechanical Report	D93	Report – Geological Modeling and Simulation for the Aquistore Project	M38	Task Force Wrap-Up Meeting Held
D33	BC Test Site – Preinjection Geochemical Report	D94	Aquistore Project Fact Sheet	M39	Editing Subgroup Meeting Held
D34	BC Test Site – Baseline Hydrogeological Experimental Design Package	D95	Aquistore Project Poster	M40	Further Characterization of the Zama Acid Gas EOR, CO_2 Storage, and Monitoring Project Completed
D41	FN Test Site – Geochemical Report	D98	Report – Findings, Recommendations and Guidance of the GCS Task Force on Operational and Postoperational Liability		
D43	BC Test Site – Monitoring Experimental Design Package			M42	Findings and Recommendations of the Operational and Postoperational Liability Subgroups Presented to the GCS Task Force
D48	BC Test Site – Procurement Plan and Agreement Report	D99	Water/CCS Nexus Related Fact Sheet		
D50	BC Test Site – Site Characterization, Modeling, and Monitoring Plan				

Table 18. PCOR Partnership Phase III Gantt Chart (BP4, PY7–PY9)

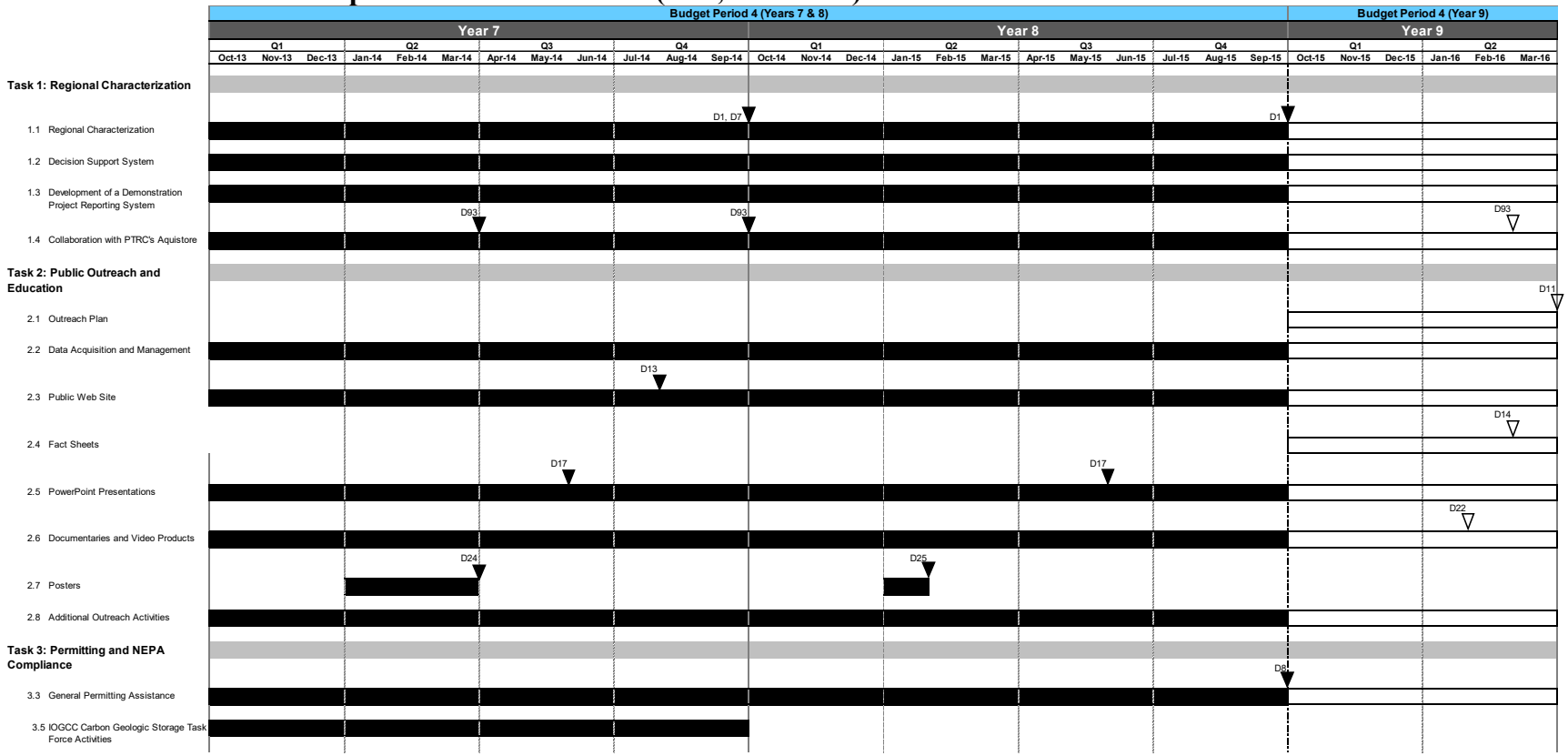

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Table 18. PCOR Partnership Phase III Gantt Chart (BP4, PY7–PY9) (continued)

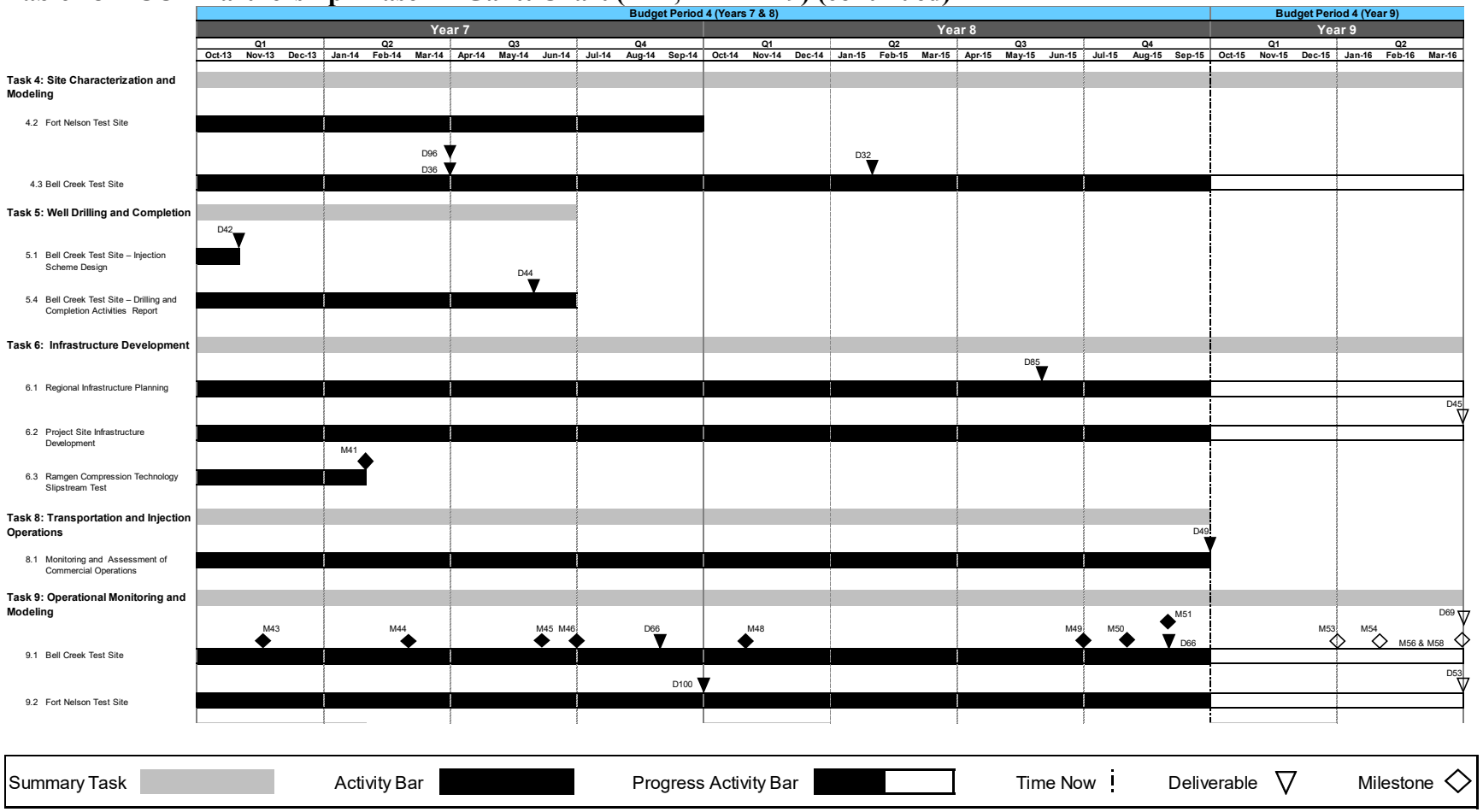

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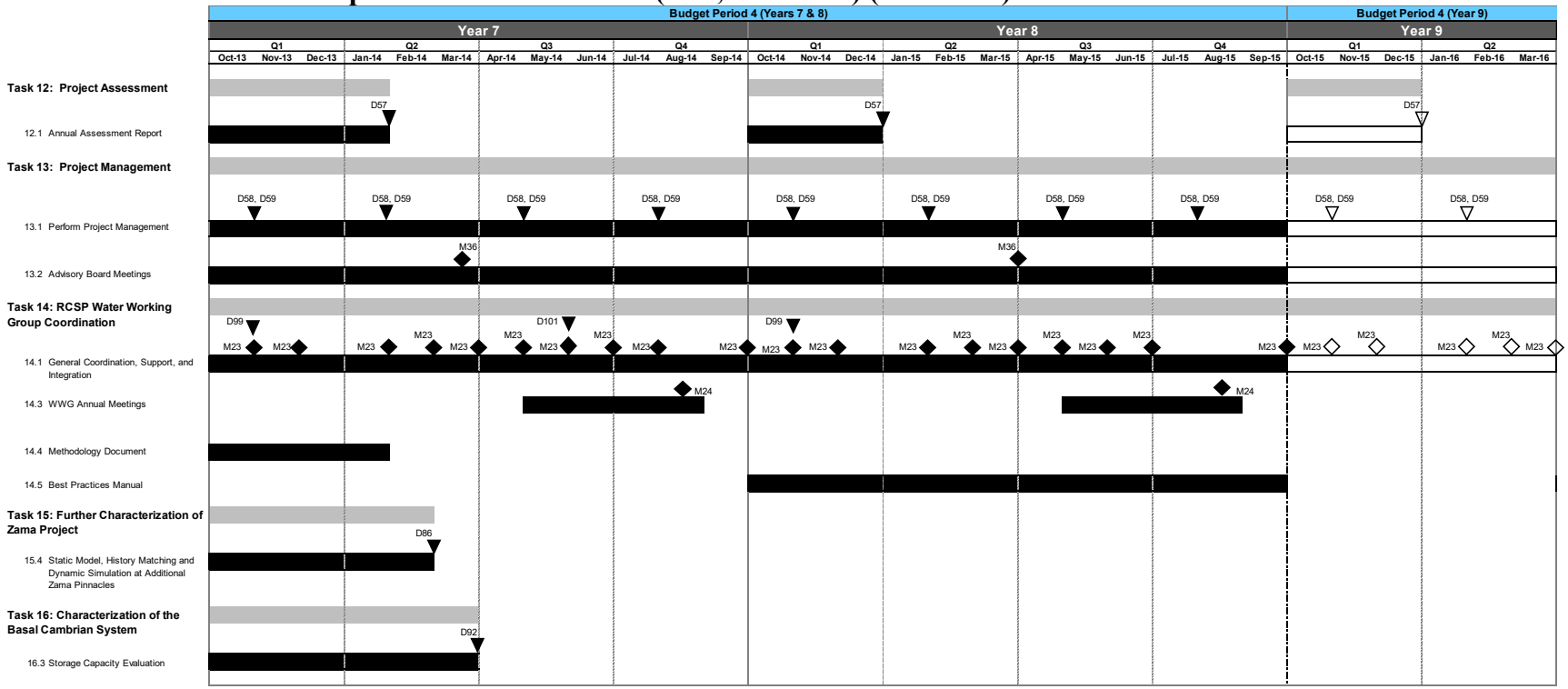
Table 18. PCOR Partnership Phase III Gantt Chart (BP4, PY7–PY9) (continued)



Key for Deliverables				Key for Milestones	
D1	Review of Source Attributes	D53	FN Test Site – Best Practices Manual – Monitoring for CO_2 Storage in a Brine Formation	M23	Monthly WWG Conference Call Held
D7	Third Target Area Completed	D57	Project Assessment Annual Report	M24	WWG Annual Meeting Held
D8	Permitting Review – Update 2	D58	Quarterly Progress Report	M36	Annual Advisory Board Meeting Scheduled
D11	Outreach Plan	D59	Milestone Quarterly Report	M41	Decision to Incorporate Ramgen Compression Technology into BC Project
D13	Public Site Updates	D66	BC Test Site – Simulation Report	M43	BC Test Site – First Full-Repeat Sampling of the Groundwater- and Soil Gas- Monitoring Program Completed
D14	General Phase III Fact Sheet	D69	BC Test Site – Best Practices Manual – Simulation	M44	BC Test Site – First 3-D VSP Repeat Surveys Completed
D17	General Phase III Information PowerPoint Presentation	D85	Report – Opportunities and Challenges Associated with CO_2 Compression and Transportation During CCUS Activities	M45	BC Test Site – First Full-Repeat of Pulsed-Neutron Logging Campaign Completed
D22	Energy from Coal 60-Minute Documentary			M46	BC Test Site – 1 Year of Injection Completed
D24	PCOR Partnership Region CO_2 Storage General Poster	D86	Updated Regional Technology Implementation Plan for Zama	M48	BC Test Site – 1 Million Metric Tons of CO_2 Injected
D25	BC Test Site Poster (Update)	D92	Report – Storage Capacity and Regional Implications for Large-Scale Storage in the Basal Cambrian System	M49	BC Test Site – 1.5 Million Metric Tons of CO_2 Injected
D32	BC Test Site – Geomechanical Report			M50	BC Test Site – 2 Years of Near-Surface Assurance Monitoring Completed
D36	BC Test Site – Wellbore Leakage Final Report	D93	Report – Geological Modeling and Simulation for the Aquistore Project	M51	BC Test Site – Initial Analysis for First Large-Scale Repeat Pulsed-Neutron Logging Campaign Post-Significant CO_2 Injection
D42	BC Test Site – Injection Experimental Design Package	D96	BC Test Site – 3-D Seismic Acquisition and Characterization Report	M53	BC Test Site – Expanded Baseline and Time-Lapse 3-D Surface Seismic Survey Completed
D44	BC Test Site – Drilling and Completion Activities Report	D99	Nexus of Water and CCS Fact Sheet	M54	BC Test Site – Initial Processing and Analysis of Historic InSAR Data Completed
D45	Report – Infrastructure Development	D100	FN Test Site – Best Practices Manual– Feasibility Study	M56	BC Test Site – Life Cycle Analysis for Primary and Secondary Recovery Oil Completed
D49	BC Test Site – Transportation and Injection Operations Report	D101	WWG Web Site Content Update	M58	BC Test Site – njection of 2.75 Million Metric Tons of CO_2 Completed

December 2015

Summary Task | Activity Bar | Progress Activity Bar | Time Now | Deliverable | Milestone

Continued…

Table 18. PCOR Partnership Phase III Gantt Chart (BP4, PY7–PY8) (continued)

Key for Deliverables ▼				Key for Milestones ◆	
D1	Review of Source Attributes	D53	FN Test Site – Best Practices Manual – Monitoring for CO_2 Storage in a Brine Formation	M23	Monthly WWG Conference Call Held
D7	Third Target Area Completed	D57	Project Assessment Annual Report	M24	WWG Annual Meeting Held
D8	Permitting Review – Update 2	D58	Quarterly Progress Report	M36	Annual Advisory Board Meeting Scheduled
D11	Outreach Plan	D59	Milestone Quarterly Report	M41	Decision to Incorporate Ramgen Compression Technology into BC Project
D13	Public Site Updates	D66	BC Test Site – Simulation Report	M43	BC Test Site – First Full-Repeat Sampling of the Groundwater- and Soil Gas- Monitoring Program Completed
D14	General Phase III Fact Sheet	D69	BC Test Site – Best Practices Manual – Simulation	M44	BC Test Site – First 3-D VSP Repeat Surveys Completed
D17	General Phase III Information PowerPoint Presentation	D85	Report – Opportunities and Challenges Associated with CO_2 Compression and Transportation During CCUS Activities	M45	BC Test Site – First Full-Repeat of Pulsed-Neutron Logging Campaign Completed
D22	Energy from Coal 60-Minute Documentary			M46	BC Test Site – 1 Year of Injection Completed
D24	PCOR Partnership Region CO_2 Storage General Poster	D86	Updated Regional Technology Implementation Plan for Zama	M48	BC Test Site – 1 Million Metric Tons of CO_2 Injected
D25	BC Test Site Poster (Update)	D92	Report – Storage Capacity and Regional Implications for Large-Scale Storage in the Basal Cambrian System	M49	BC Test Site – 1.5 Million Metric Tons of CO_2 Injected
D32	BC Test Site – Geomechanical Report			M50	BC Test Site – 2 Years of Near-Surface Assurance Monitoring Completed
D36	BC Test Site – Wellbore Leakage Final Report	D93	Report – Geological Modeling and Simulation for the Aquistore Project	M51	BC Tast Site – Initial Analysis for First Large-Scale Repeat Pulsed-Neutron Logging Campaign Post-Significant CO_2 Injection
D42	BC Test Site – Injection Experimental Design Package	D96	BC Test Site – 3-D Seismic Acquisition and Characterization Report	M53	BC Test Site – Expanded Baseline and Time-Lapse 3-D Surface Seismic Survey Completed
D44	BC Test Site – Drilling and Completion Activities Report	D99	Nexus of Water and CCS Fact Sheet	M54	BC Test Site – Initial Processing and Analysis of Historic InSAR Data Completed
D45	Report – Infrastructure Development	D100	FN Test Site – Best Practices Manual– Feasibility Study	M56	BC Test Site – Life Cycle Analysis for Primary and Secondary Recovery Oil Completed
D49	BC Test Site – Transportation and Injection Operations Report	D101	WWG Web Site Content Update	M58	BC Test Site – nljection of 2.75 Million Metric Tons of CO_2 Completed

Revised 10/29/15

PLANNED ACTIVITIES

Task 1 – Regional Characterization

During the next program year (October 1, 2015 – September 30, 2016), 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 work with the geological surveys/oil and gas divisions of the states and provinces to develop greater detail of the field and reservoir data.
- Continue to update the DSS, and report changes in the quarterly progress reports.
- Finalize a value-added white paper on the characterization of relevant oil fields located in the Cedar Creek Anticline.
- Prepare an update to the geological monitoring and simulation for the Aquistore project (D93).
- Prepare the next edition of the PCOR Partnership Atlas (D81) by August 31, 2016, ideally in time to distribute at the 2016 Annual Membership Meeting.

Task 2 – Public Outreach and Education

During the next program year (October 1, 2015 – September 30, 2016), the following activities will be undertaken:

- Update the general Phase III fact sheet (D14).
- Update the outreach plan (D11).
- Continue to review and improve the public PCOR Partnership Web site (D13).
- Update the PowerPoint presentation for Phase III general activities (D17). Other PowerPoint presentations may be developed as needed.
- Continue to develop video products to meet the needs of general and site-level outreach.
- Perform production activities with regard to the Bell Creek Test Site 30-minute documentary.
- Continue filming interviews and B-roll for the 60-minute documentary (D22) entitled "Coal and the Modern Age," including a filming trip with PPB to China.

- Continue to collaborate with PTRC on outreach activities related to the Aquistore project. These activities may include assisting in assembling material for public presentations, assisting in collection of information about public perception, participating in meetings with PTRC about public outreach activities, and collecting video of the activities at the project site.

- Continue to update project-related fact sheets, and develop new fact sheets as needed.

- Continue to 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 and the Aquistore Project Communications Advisory Group.

Task 3 – Permitting and NEPA Compliance

During the next program year (October 1, 2015 – September 30, 2016), 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.

- Continue to facilitate the Regulatory Roundup meeting with regulators in the PCOR Partnership region.

- 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.

Task 4 – Site Characterization and Modeling

During the next program year (October 1, 2015 – September 30, 2016), the following activities will be undertaken:

- Bell Creek Test Site
  - Complete V3 of the geologic model.

  - Use knowledge gained from enhanced site characterization to continue working on the BPM on site characterization (D35), which has been extended to PY10.

Task 5 – Well Drilling and Completion

This task ended June 30, 2014. No further activity is anticipated.

Task 6 – Infrastructure Development

During the next program year (October 1, 2015 – September 30, 2016), the following activities will be undertaken:

- Prepare an infrastructure development report (D45).
- Update the interactive capture technologies table on the DSS.
- Complete an interactive table of compression technologies for the DSS.
- Continue to investigate regional infrastructure needs. Information will be made available for possible inclusion in the DSS.
- Continue to assist commercial partners with the activities required to develop the infrastructure to deliver CO_2 to the EOR site for the Bell Creek demonstration.

Task 7 – CO_2 Procurement

This task ended September 30, 2013. No further activity is anticipated.

Task 8 – Transportation and Injection Operations

This task ended September 30, 2015. No further activity is anticipated.

Task 9 – Operational Monitoring and Modeling

During the next program year (October 1, 2015 – September 30, 2016), the following activities will be undertaken:

- Bell Creek Test Site
  - Complete the expanded baseline and time-lapse 3-D surface seismic survey (M53).
  - Complete the enhanced PNL campaign with anticipated logging on 18 wells.
  - Complete the initial processing and analysis of historic InSAR (interferometric synthetic aperture radar) data (M54).
  - Prepare a BPM for CO_2 EOR and storage modeling simulations (D69).
  - Continue to provide a quarterly summary of injection operations in the quarterly technical progress reports.

- Achieve 2.75 million metric tons of CO_2 stored (M58) by March 31, 2016.
- Update the simulation report (D66) by August 31, 2016.
- Perform the life cycle assessment activities, and complete M56 and M57.

Task 10 – Site Closure

During the next program year, this task will be initiated at the beginning of BP5 (April 1, 2016). The activities to be undertaken will be determined in the BP5 continuation application and may include the following:

- Initiate site closure activities as appropriate.

Task 11 – Postinjection Monitoring and Modeling

During the next program year, this task will be initiated at the beginning of BP5 (April 1, 2016). The activities to be undertaken will be determined in the BP5 continuation application and may include the following:

- Compare early modeling results with actual field data.
- Develop a long-term MVA plan to present in D55 by September 30, 2016.

Task 12 – Project Assessment

During the next program year (October 1, 2015 – September 30, 2016), the following activities will be undertaken:

- Prepare the Annual Project Assessment Report (D57).

Task 13 – Project Management

During the next program year (October 1, 2015 – September 30, 2016), the following activities will be undertaken:

- Prepare the BP5 continuation application.
- Continue to ensure timely production of deliverables and overall project management.
- Continue to expand the PCOR Partnership's membership base.
- Continue to update the TAB, and execute at least one meeting prior to the next annual meeting.
- Plan the next annual meeting.

- Continue to participate in and support RCSP efforts.
- Update the project management plan as necessary.
- Update the risk management plan as necessary.
- Complete the adaptive management approach BPM (D102) by August 31, 2016.

Task 14 – RCSP WWG Coordination

During the next program year (October 1, 2015 – September 30, 2016), the following activities will be undertaken:

- Continue to conduct monthly WWG conference calls.
- Plan and conduct the 7th annual meeting of the WWG.
- Update the WWG Web site content as appropriate.
- Continue working on the special issue of IJGGC focused on the issues at the nexus of water and CCS.

Task 15 – Further Characterization of the Zama Acid Gas EOR, CO_2 Storage, and Monitoring Project

This task ended February 28, 2014. No further activity is anticipated.

Task 16 – Basal Cambrian System Characterization

This task ended March 31, 2014. No further activity is anticipated.

PLANNED SCHEDULE

Table 19 contains all of the Phase III deliverables, milestones, and submission dates for PY9 (October 1, 2015 – September 30, 2016). Dates are subject to change with the BP5 continuation application.

Table 19. Phase III Milestones and Deliverables

Title/Description	Due Date	Actual Completion Date
Year 9 – Quarter 1 (October–December 2015)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	10/31/15	
M23: Task 14 – Monthly WWG Conference Call Held	10/31/15	
M23: Task 14 – Monthly WWG Conference Call Held	11/30/15	
D57: Task 12 – Project Assessment Annual Report	12/31/15	
M24: Task 14 – WWG Annual Meeting Held	12/31/15	8/20/15
M53: Task 9 – Expanded Baseline and Time-Lapse 3-D Surface Seismic Survey Completed	12/31/15	
Year 9 – Quarter 2 (January–March 2016)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	1/31/16	
D22: Task 2 – Energy from Coal 60-minute Documentary	1/31/16	
M23: Task 14 – Monthly WWG Conference Call Held	1/31/16	
M54: Task 9 – Initial Processing and Analysis of Historic InSAR Data Completed	1/31/16	
D14: Task 2 – General Phase III Fact Sheet (Update)	2/29/16	
D93: Task 1 – Geological Modeling and Simulation Report for the Aquistore Project (Update 2)	2/29/16	
M23: Task 14 – Monthly WWG Conference Call Held	2/29/16	
D11: Task 2 – Outreach Plan (Update)	3/31/16	
D45: Task 6 – Bell Creek Test Site – Infrastructure Development Report	3/31/16	
D53: Task 9 – Fort Nelson Test Site – Monitoring for CO_2 Storage in a Brine Formation Best Practices Manual	3/31/16	
D55: Task 11 – Bell Creek Test Site – Cost-Effective Long-Term Monitoring Strategies Report	3/31/16	
D69: Task 9 – Bell Creek Test Site – Best Practices Manual – Simulation Report	3/31/16	
M23: Task 14 – Monthly WWG Conference Call Held	3/31/16	
M36: Task 13 – Annual Advisory Board Meeting Scheduled	3/31/16	
M56: Task 9 – Life Cycle Analysis for Primary and Secondary Recovery Oil Completed	3/31/16	

Continued . . .

Table 19. Phase III Milestones and Deliverables (continued)

Title/Description	Due Date	Actual Completion Date
Year 9 – Quarter 3 (April–June 2016)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	4/30/16	
D15: Task 2 – Bell Creek Test Site Fact Sheet (Update)	4/16/16	
D16: Task 2 – Fort Nelson Test Site Fact Sheet (Update)	4/30/16	
D21: Task 2 – Bell Creek Test Site 30-minute Documentary	4/30/16	
D56: Task 11 – Report – Cost-Effective Long-Term Monitoring Strategies for the Fort Nelson Test Site	4/30/16	
M23: Task 14 – Monthly WWG Conference Call Held	4/30/16	
D17: Task 2 – General Phase III Information PowerPoint Presentation (Update)	5/31/16	
D101: Task 14 – WWG Web Site Content Update 1	5/31/16	
M23: Task 14 – Monthly WWG Conference Call Held	5/31/16	
M57: Task 9 – Life Cycle Analysis for EOR (enhanced oil recovery) at the Bell Creek Field Completed	5/31/16	
M23: Task 14 – Monthly WWG Conference Call Held	6/30/16	
Year 9 – Quarter 4 (July–September 2016)		
D58/D59: Task 13 – Quarterly Progress Report/Milestone Quarterly Report	7/31/16	
D13: Task 2 – Public Site Updates	7/31/16	
D70: Task 9 – Fort Nelson Test Site – Best Practices Manual – Simulation Report	7/31/16	
M23: Task 14 – Monthly WWG Conference Call Held	7/31/16	
D66: Task 9 – Bell Creek Test Site – Simulation Report (Update)	8/31/16	
D81: Task 1 – Regional Carbon Sequestration Atlas (Update)	8/31/16	
D102: Task 13 – Best Practices Manual – Adaptive Management Approach	8/31/16	
D103: Task 13 – Best Practices Manual – Programmatic Risk Management	8/31/16	
M23: Task 14 – Monthly WWG Conference Call Held	8/31/16	
D1: Task 1 – Review of Source Attributes (Update)	9/30/16	
D73: Task 11 – Bell Creek Test Site –Monitoring and Modeling Fate of CO_2 Progress Report	9/30/16	
M23: Task 14 – Monthly WWG Conference Call Held	9/30/16	

TRAVEL

Representatives from the PCOR Partnership attended and/or participated in the following 48 meetings/conferences, 12 workshops, six training opportunities, and 23 project management site trips in this reporting period. As the Phase III program nears the end of BP4, travel decreased in PY8 compared to PY7. There were fewer meetings/conferences/workshops (60 compared to 66 in PY7) and fewer site trips were made during the operational monitoring phase (23 versus 32). The training opportunities increased (six versus three in PY7); additionally training was provided in-house and by Webinar.

- October 5–9, 2014: traveled to Austin, Texas, to present at the GHGT-12 Conference.
- October 14–15, 2014: traveled to Washington, D.C., to attend the Executive Roundtable "Commercial & Financial Structuring of Commercial-Scale Projects with Carbon Capture and Sequestration."
- October 18–22, 2014: traveled to Columbus, Ohio, for the IOGCC annual meeting.
- October 19–27, 2014: traveled to Gillette, Wyoming, for site work at the Bell Creek Field.
- October 23–24, 2014: traveled to Midland, Texas, to present at the CCUS Workshop.
- October 23–27, 2014: traveled to Gillette, Wyoming, for site work at the Bell Creek Field.
- October 27–31, 2014: traveled to Gillette, Wyoming, for site work at the Bell Creek Field.
- October 30 – November 4, 2014: traveled to Gillette, Wyoming, for site work at the Bell Creek Field.
- November 4–7, 2014: traveled to Champaign, Illinois, to attend the 2014 Midwest Carbon Sequestration Science Conference.
- November 5–11, 2014: traveled to Gillette, Wyoming, for site work at the Bell Creek Field.
- November 7–13, 2014: traveled to Beijing, China, to present at the APEC Expert Workshops on CCUS and for academic exchange discussion.
- November 13–14, 2014: traveled to Plano, Texas, to attend meetings with Denbury.
- November 17–19, 2014: traveled to Columbus, Ohio, to attend the Midwest Regional Carbon Sequestration Partnership Annual Partners Meeting.
- November 20–21, 2014: traveled to Washington, D.C., to attend the Subsurface Technology Engineering Challenges Briefing.
- November 20–24, 2014: traveled to Denver, Colorado, for meetings with C12 Energy. November 21, 2014: traveled to Fargo, North Dakota, to meet with the PPB Educational Department.
- November 30 – December 7, 2014: traveled to Gillette, Wyoming, for sampling at the Bell Creek Field.
- December 3–4, 2014: traveled to Morgantown, West Virginia, to visit DOE.
- December 7–12, 2014: traveled to Midland, Texas, to attend and present at CO_2 Conference Week.
- December 10, 2014: traveled to Fargo, North Dakota, to present at a GIS class at North Dakota State University.
- December 10–12, 2014: traveled to Estevan, Saskatchewan, Canada, for a community open house for the Aquistore Project.
- December 12–18, 2014: traveled to San Francisco, California, to attend the American Geophysical Union Fall Conference.

- December 14–20, 2014: traveled to Gillette, Wyoming, for sampling at the Bell Creek Field.
- December 15–16, 2014: traveled to Bismarck, North Dakota, to attend the Williston Basin Society of Petroleum Engineers (SPE) Meeting and SPE Board Meeting.
- January 11–14, 2015: traveled to Houston, Texas, to conduct interviews and film for the coal documentary.
- January 14–16, 2015: traveled to Miles City, Montana, for site work at the Bell Creek Station.
- January 23–28, 2015: traveled to Arlington, Virginia, to attend the National Energy Education Summit.
- February 8–12, 2015: traveled to Austin, Texas, to attend the 2015 UIC Conference.
- February 9–14, 2015: traveled to Gillette, Wyoming, for site work at the Bell Creek Field.
- February 12–15, 2015: traveled to Chicago, Illinois, for a site inspection and contract negotiations for the 2015 PCOR Partnership Annual Membership Meeting.
- February 27 – March 5, 2015: traveled to Phoenix, Arizona, to attend the PCOR Partnership TAB meeting and other partner meetings.
- March 10–12, 2015: traveled to Atlanta, Georgia, to attend the SECARB annual meeting.
- March 11–13, 2015: traveled to Calgary, Alberta, Canada, to present at the Research Issues in Gas Migrating along Wellbores Workshop.
- March 14–16, 2015: traveled to Livermore, California, to present at the Enhanced Water Recovery Workshop hosted by DOE.
- March 24–29, 2015: traveled to Athens, Greece, to present at the International Forum on Recent Developments of Carbon Capture & Sequestration Implementation.
- April 10–13, 2015: traveled to Plano, Texas, for update meetings with Denbury.
- April 20–25, 2015: traveled to Paris, France, to present at the 7th IEA International Carbon Capture and Sequestration Regulatory Network meeting.
- April 22–24, 2015: traveled to Miles City, Montana, for Bell Creek site work.
- April 22 – May 1, 2015: traveled to Gillette, Wyoming, for Bell Creek project work.
- April 27–30, 2015: traveled to Regina, Saskatchewan, Canada, to attend the Williston Basin Petroleum Conference.
- April 27 – May 2, 2015: traveled to Pittsburgh, Pennsylvania, to present at CCUS-14.
- April 28 – May 1, 2015: traveled to Miles City, Montana, for Bell Creek site work.
- May 9–14, 2015: traveled to Venice, Italy, to present at the 10th CO_2 GeoNet Open Forum and Workshop.
- May 16–21, 2015: traveled to Salt Lake City, Utah, to attend the IOGCC annual meeting.
- May 28–29, 2015: traveled to Estevan, Saskatchewan, Canada, to attend and film the Aquistore project ribbon-cutting ceremony.
- June 9–14, 2015: traveled to Berkeley, California, to present at the IEAGHG 10th Monitoring Network Meeting.
- June 11, 2015: traveled to Fargo, North Dakota, to meet with PPB education staff regarding the Teacher Training Institute.
- June 15–18, 2015: traveled to Regina, Saskatchewan, to present at the CSLF Mid-Year Meeting.
- June 16, 2015: traveled to Bismarck, North Dakota, to present at the LEC teacher workshop.
- June 22–25, 2015: traveled to Meridian, Mississippi, to film locations and obtain interviews at Southern Company's Kemper County Energy Facility to use in the Coal and the Modern Age documentary.

- June 22–28, 2015: traveled to Gillette, Wyoming, for sampling at the Bell Creek site.
- June 23–24, 2015: traveled to Moorhead, Minnesota, to present at the Prairie Public Teacher Training Institute.
- June 26 – July 8, 2015: traveled to San Francisco, California, to attend the 2015 U.S. Rock Mechanics Geomechanics Symposium and Workshop.
- June 29 – July 1, 2015: traveled to White Salmon, Washington, to work as a technical advisor on the Coal and the Modern Age documentary.
- July 6–8, 2015: Traveled to Hulett, Wyoming, to do maintenance on the 04-03 OW borehole array recording system at Bell Creek.
- July 8–18, 2015: Traveled to Houston, Texas, to attend three CMG courses (CMOST, July 9–10, WINPROP, July 13–14, and Reservoir Simulation, July 15–17).
- July 13–17, 2015: Traveled to Casper, Wyoming, to attend the EOR CO_2 Conference and workshops.
- July 20–22, 2015: Traveled to Deadwood, South Dakota, to attend the WBI Energy Customer Meeting.
- July 21–23, 2015: Traveled to Deadwood, South Dakota, to host the PCOR Partnership Regulatory Roundup.
- July 27–28, 2015: Traveled to Fargo, North Dakota, to work with PPB for the upcoming documentary.
- August 1–9, 2015: Traveled to Calgary, Alberta, Canada, to attend CMG's EOR Modeling Using GEM training course.
- August 4–6, 2015: Traveled to Gillette, Wyoming, to meet with landowners for the Bell Creek project.
- August 9–12, 2015: Traveled to Denver, Colorado, to view cores at the USGS CRC.
- August 12, 2015: Traveled to Carrington, North Dakota, to present at the North Dakota Member Services Association summer meeting.
- August 16–22, 2015: Traveled to St. John's, Newfoundland, Canada, to attend the Society of Core Analysts Symposium and field trip "Stratigraphy of the Neoproterozoic–Cambrian" near St. John's.
- August 17–20, 2015: Traveled to Pittsburgh, Pennsylvania, to host the WWG annual meeting and attend the U.S.–Norway data-sharing workshop/meeting, present at the 2015 DOE Carbon Storage R&D Project Review Meeting, and attend the NRAP Stakeholders Meeting.
- August 24–27, 2015: Traveled to Billings, Montana, to attend the China Inaugural Clean Coal Initiative meeting.
- August 24–28, 2015: Traveled to Miles City, Montana, for Bell Creek site sampling work.
- August 23 – September 1, 2015: traveled to Gillette, Wyoming, for sampling at the Bell Creek site.
- September 4–7, 2015: Traveled to Oslo, Norway, to present at the CO_2 and MVA Workshop.
- September 4–12, 2015: Traveled to Biarritz, France, to present at the EAGE Petroleum Geostatistics Conference.
- September 7–11, 2015: Traveled to Regina, Saskatchewan, Canada, to attend the IEAGHG PCCC3.
- September 12–17, 2015: Traveled to Chicago, Illinois, to host and present at the PCOR Partnership Annual Membership Meeting, the CO_2 EOR Workshop, the TAB meeting, and an Aquistore project update meeting.

- September 21–23, 2015: Traveled to Fargo, North Dakota, to attend the North Dakota Petroleum Council annual meeting.
- September 24–25, 2015: Traveled to Plano, Texas, to attend meetings with and present to Denbury.
- September 26–27, 2015: Traveled to Houston, Texas, to attend NExT training with Schlumberger.
- September 26 – October 1, 2015: Traveled to Oklahoma City, Oklahoma, to attend the IOGCC annual meeting.
- September 27 – October 1, 2015: Traveled to Southampton, United Kingdom, to present at the IEAGHG Risk Management & Environmental Research Combined Network meetings.
- September 28–29, 2015: Traveled to Houston, Texas, to attend Petrel Fundamentals training.
- September 28–29, 2015: Traveled to Fargo, North Dakota, to attend the GIS Users Conference.

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

PHASE III PRODUCTS/PUBLICATIONS

During PY8, the PCOR Partnership submitted 20 abstracts (all were accepted), the author declined one, and one was not presented. The PCOR Partnership had ten conference papers prepared and gave 61 presentations (oral and poster combined). In addition, it completed 15 deliverable/milestone reports (12 were finalized), two value-added products, and 16 progress reports (monthlies and quarterlies combined) and prepared several conference call and meeting minutes.

Abstracts

Submitted, Accepted, and Declined by Author (1)

Wilson, W.I., Doll, T.E., Gorecki, C.D., Ayash, S.C., Steadman, E.N., and Harju, J.A., 2015, Permitting for carbon capture and storage in the Plains CO_2 Reduction Partnership region [abs.]: Transforming Technology Through Integration and Collaboration Carbon Storage R&D Project Review Meeting, Pittsburgh, Pennsylvania, August 18–20, 2015.

Submitted and Accepted for Presentation (8)

Daly, D.J., Crocker, C.R., Crossland, J.L., Gorecki, C.D., and Steadman, E.N., 2015, PCOR Partnership outreach – a multifaceted program [abs.]: Transforming Technology Through Integration and Collaboration Carbon Storage R&D Project Review Meeting, Pittsburgh, Pennsylvania, August 18–20, 2015.

Gorecki, C.D., Ayash, S.C., Klapperich, R.J., Sorensen, J.A., Hamling, J.A., Steadman, E.N., and Harju, J.A., 2015, An adaptive management approach to CO_2 storage projects [abs.]: 10th CO_2GeoNet Open Forum, San Servolo Island, Venice, Italy, May 11–12, 2015.

Gorecki, C.D., Daly, D.J., Crocker, C.R., Crossland, J.L., and Steadman, E.N., 2015, PCOR Partnership outreach—over a decade of activity [abs.]: 10th CO_2GeoNet Open Forum, San Servolo Island, Venice, Italy, May 11–12, 2015.

Gorecki, C.D., Hamling, J.A., Sorensen, J.A., Peck, W.D., Daly, D.J., Jensen, M.D., Klapperich, R.J., Ayash, S.C., Anagnost, K.K., Steadman, E.N., and Harju, J.A., 2015, Implementing carbon capture and storage—an overview of the Plains CO_2 Reduction Partnership [abs.]: 14th Annual Carbon Capture, Utilization & Storage Conference, Pittsburgh, Pennsylvania, April 28 – May 1, 2015.

Gorecki, C.D., Steadman, E.N., Harju, J.A., Hamling, J.A., Sorensen, J.A., Peck, W.D., Daly, D.J., Jensen, M.D., Klapperich, R.J., Ayash, S.C., and Anagnost, K.K., 2015, The Plains CO_2 Reduction Partnership—demonstrating the geologic storage of carbon dioxide [abs.]: 10th CO_2GeoNet Open Forum, San Servolo Island, Venice, Italy, May 11–12, 2015.

Gorecki, C.D., Steadman, E.N., Harju, J.A., Hamling, J.A, Sorensen, J.A., Peck, W.D., Daly, D.J., Jensen, M.D., Klapperich, R.J., Ayash, S.C., and Anagnost, K.K., 2014, The Plains CO_2 Reduction Partnership—demonstrating carbon dioxide storage in the United States and Canada [abs.]: International Forum on Recent Developments of CCS Implementation, Athens, Greece, March 26–27, 2015.

Peck, W.D., and Gorecki, C.D., 2015, Geologic modeling and simulation at the Aquistore site—a guide to MVA deployment [abs.]: 14th Annual Carbon Capture, Utilization & Storage Conference, Pittsburgh, Pennsylvania, April 28 – May 1, 2015.

Peck, W.D., Gorecki, C.D., Steadman, E.N., Doll, T.E., and Harju, J.A., 2015, Technical interpretation of the transition of CO_2 EOR to geologic storage [abs.]: 14th Annual Carbon Capture, Utilization & Storage Conference, Pittsburgh, Pennsylvania, April 28 – May 1, 2015.

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Bosshart, N.W., Braunberger, J.R., Burton-Kelly, M.E., Dotzenrod, N.W., and Gorecki, C.D., 2015, Multiscale reservoir modeling for CO_2 storage and enhanced oil recovery using multiple point statistics [abs.]: EAGE Petroleum Geostatistics 2015 Conference, Biarritz, France, September 7–11, 2015.

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Hawthorne, S.B., Miller, D.J., Gorecki, C.D., Sorensen, J.A., Steadman, E.N., and Harju, J.A., 2015, Effects of reservoir temperature and percent levels of methane and ethane on CO_2/oil MMP values as determined using vanishing interfacial tension/capillary rise [abs.]: Transforming Technology Through Integration and Collaboration Carbon Storage R&D Project Review Meeting, Pittsburgh, Pennsylvania, August 18–20, 2015.

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Sorensen, J.A., Smith, S.A., Gorecki, C.D., Steadman, E.N., and Harju, J.A., 2015, The adaptive management approach to CCS project planning—the Fort Nelson CCS project as a case study [abs.]: Transforming Technology Through Integration and Collaboration Carbon Storage R&D Project Review Meeting, Pittsburgh, Pennsylvania, August 18–20, 2015.

Submitted and Accepted for Poster But Not Presented (1)

Hamling, J.A., Klapperich, R.J., and Kalenze, N.S., 2015, Risk assessment using an adaptive management approach to CO_2 storage projects [abs.]: IEAGHG Risk Management and Environmental Research Combined Networks Meeting, Southampton, UK, September 29 – October 1, 2015.

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Bosshart, N.W., 2015, Bell Creek version 3 geologic model update: Presented to Denbury Resources Inc. personnel, Bell Creek Project Update Meeting, Plano, Texas, September 24–25, 2015.

Bosshart, N.W., 2015, Bell Creek version 3 geologic model update—a new geologic interpretation: Presented at the Bell Creek Project Update Meeting, Plano, Texas, April 13, 2015.

Bosshart, N.W., and Hamling, J.A., 2015, Bell Creek pulsed-neutron well-logging update: Presented to Denbury Resources Inc. personnel, Bell Creek Project Update Meeting, Plano, Texas, September 24–25, 2015.

Bosshart, N.W., Hamling, J.A., and Gorecki, C.D., 2015, Thoughts on a potential tracer study in Phase 1, Bell Creek Field: Presented at the Bell Creek Project Update Meeting, Plano, Texas, April 13, 2015.

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Daly, D.J., Crocker, C.R., Gorecki, C.D., Steadman, E.N., and Harju, J.A., 2015, Energy and CO_2 management—carbon capture and storage: Presented at the Energy, Economics & Environment 2015 Lignite Education Seminar, Bismarck, North Dakota, June 15–18, 2015.

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Dotzenrod, N.W., 2014, An overview of the Plains CO_2 Reduction (PCOR) Partnership and its project geospatial tools: Lecture for Introduction to GIS presented at North Dakota State University, Fargo, North Dakota, December 10, 2014.

Gorecki, C.D., and Ayash, S.C., 2015, A Bell Creek road map…: Presented to Denbury Resources Inc. personnel, Bell Creek Project Update Meeting, Plano, Texas, September 24–25, 2015.

Gorecki, C.D., and Ayash, S.C., 2015, Plains CO_2 Reduction (PCOR) Partnership highlights: Presented at the PCOR Partnership Annual Membership Meeting, Chicago, Illinois, September 16–17, 2015.

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Gorecki, C.D., and Ayash, S.C., 2015, The Plains CO_2 Reduction (PCOR) Partnership—Bell Creek Field project: Presented at Transforming Technology Through Integration and Collaboration Carbon Storage R&D Project Review Meeting, Pittsburgh, Pennsylvania, August 18–20, 2015.

Gorecki, C.D., Ayash, S.C., Hamling, J.A., and Peck, W.D., 2015, PCOR Partnership Technical Advisory Board meeting: Presentation for the 2015 PCOR Partnership Technical Advisory Board Meeting, Phoenix, Arizona, March 2–3, 2015.

Gorecki, C.D., Ayash, S.C., Klapperich, R.J., Sorensen, J.A., Hamling, J.A., Steadman, E.N., and Harju, J.A., 2015, An adaptive management approach to CO_2 storage projects: Presented at the 10th CO_2GeoNet Open Forum, San Servolo Island, Venice, Italy, May 11–12, 2015.

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Gorecki, C.D., Hamling, J.A., Braunberger, J.R., Klapperich, R.J., and Ayash, S.C., 2014, Bell Creek activities update: Presented to U.S. Department of Energy National Energy Technology Laboratory personnel, Morgantown, West Virginia, December 3, 2014.

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Gorecki, C.D., Hamling, J.A., Sorensen, J.A., Peck, W.D., Daly, D.J., Jensen, M.D., Klapperich, R.J., Ayash, S.C., Anagnost, K.K., Steadman, E.N., and Harju, J.A., 2015, The Plains CO_2 Reduction Partnership—demonstrating carbon dioxide storage in the United States and Canada: Presented at the International Forum on Recent Developments of CCS Implementation, Athens, Greece, March 26–27, 2015.

Gorecki, C.D., Steadman, E.N., Harju, J.A., Hamling, J.A., Sorensen, J.A., Peck, W.D., Daly, D.J., Jensen, M.D., Klapperich, R.J., Ayash, S.C., and Anagnost, K.K., 2015, Implementing carbon capture and storage—an overview of the Plains CO_2 Reduction Partnership: Presented at the 10th CO_2GeoNet Open Forum, San Servolo Island, Venice, Italy, May 11–12, 2015.

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Harju, J.A., 2014, Overview of carbon dioxide enhanced oil recovery (EOR): Presented at the Asia-Pacific Economic Cooperation (APEC) Expert Workshops on Carbon Capture Utilization and Storage–Enhanced Oil Recovery (CCUS–EOR), Beijing, China, November 10–11, 2014.

Hawthorne, S.B., Miller, D.J., Gorecki, C.D., Sorensen, J.A., Hamling, J.A., Roen, T.D., Steadman, E.N, Harju, J.A., and Melzer, L.S., 2014, A rapid method for determining CO_2–oil MMP and visual observations of CO_2–oil interactions at reservoir conditions: Presented at the International Conference on Greenhouse Gas Technologies (GHGT-12), Austin, Texas, October 5–9, 2014.

Jin, L., 2015, History match and performance prediction for Bell Creek Phase 1 and 2 area: Presented to Denbury Resources Inc. personnel, Bell Creek Project Update Meeting, Plano, Texas, September 24–25, 2015.

Klapperich, R.J., Nakles, D.V., and McNemar, A.T., 2015, RCSP Water Working Group annual meeting: Presented at the Regional Carbon Sequestration Partnerships Water Working Group Annual Meeting, Pittsburgh, Pennsylvania, August 18, 2015.

Klapperich, R.J., Stepan, D.J., Jensen, M.D., Gorecki, C.D., Steadman, E.N., Harju, J.A., Nakles, D.V., and McNemar, A.T., 2014, The nexus of water and CCS—a regional carbon sequestration partnership perspective: Presented at the International Conference on Greenhouse Gas Technologies (GHGT-12), Austin, Texas, October 5–9, 2014.

Leroux, K.M., and Hamling, J.A., 2015, 05-06 OW AZMI pressure analysis: Presented to Denbury Resources Inc. personnel, Bell Creek Project Update Meeting, Plano, Texas, September 24–25, 2015.

Leroux, K.M., and Hamling, J.A., 2015, 05-06 OW AZMI pressure analysis: Presented at the Bell Creek Project Update Meeting, Plano, Texas, April 13, 2015.

Peck, W.D., 2014, A workflow to determine CO_2 storage potential in deep saline formations: Presented at the International Conference on Greenhouse Gas Technologies (GHGT-12), Austin, Texas, October 5–9, 2014.

Peck, W.D., 2015, CO_2 EOR—a framework for CO_2 storage: Presented at the CO_2 Enhanced Oil Recovery (EOR) Workshop, PCOR Partnership Annual Membership Meeting, Chicago, Illinois, September 15, 2015.

Peck, W.D., 2014, Update on EERC Aquistore efforts: Presented via WebEx/conference call with Science and Engineering Research Council (SERC) personnel for the Aquistore modeling update, Grand Forks, North Dakota, October 2, 2014.

Peck, W.D., and Ayash, S.C., 2015, PCOR Technical Advisory Board discussion on transition of CO_2 EOR to CO_2 storage: Presentation for the PCOR Technical Advisory Board Webinar, June 22, 2015.

Peck, W.D., and Gorecki, C.D., 2015, Geologic modeling and simulation at the Aquistore site—a guide to MVA deployment: Presented at the 14th Annual Carbon Capture, Utilization & Storage Conference, Pittsburgh, Pennsylvania, April 28 – May 1, 2015.

Sorensen, J.A., Botnen, L.S., Smith, S.A., Gorecki, C.D., Steadman, E.N., and Harju, J.A., 2014, Application of Canadian Standards Association guidelines for geologic storage of CO_2 toward the development of a monitoring, verification, and accounting plan for a potential CCS project at Fort Nelson, British Columbia, Canada: Presented at the International Conference on Greenhouse Gas Technologies (GHGT-12), Austin, Texas, October 5–9, 2014.

Sorensen, J.A., Gorecki, C.D., Steadman, E.N., and Harju, J.A., 2015, An overview of the Plains CO_2 Reduction (PCOR) Partnership: Presented to China Coal Information Institute personnel, Grand Forks, North Dakota, April 13, 2015.

Sorensen, J.A., Hamling, J.A., and Azzolina, N., 2015, The value of multiple rounds of risk assessment to CCS project planning—the Fort Nelson CCS project as a case study: Presented

at the IEAGHG Risk Management and Environmental Research Combined Networks Meeting, Southampton, UK, September 29 – October 1, 2015.

Steadman, E.N., 2014, EERC Oil and Gas Group—current projects and paths forward: Presented to Steffes Corporation personnel, Grand Forks, North Dakota, October 15, 2014.

Steadman, E.N., 2015, Lessons learned from enhanced oil recovery operations—the Plains CO_2 Reduction Partnership: Presented at the 2015 Carbon Sequestration Leadership Forum (CSLF) Technology Workshop, Regina, Saskatchewan, June 17, 2015.

Steadman, E.N., 2015, Plains CO_2 Reduction (PCOR) Partnership and oil and gas overview: Presented to Praxair, Inc., personnel, Grand Forks, North Dakota, July 14, 2015.

Steadman, E.N., 2015, Research that is making a difference at the Energy & Environmental Research Center: Presented at the North Dakota Member Services Association (NDMSA) 2015 Summer Meeting, Carrington, North Dakota, August 12, 2015.

Steadman, E.N., 2015, The Plains CO_2 Reduction (PCOR) Partnership EOR and storage demonstration projects: Presented at the Workshop on CCS–EOR Utilization and Storage, Beijing, China, April 16, 2015.

Steadman, E.N., 2015, The Plains CO_2 Reduction (PCOR) Partnership—project updates: Presented at the Plains CO_2 Reduction (PCOR) Partnership Regulatory Roundup, Deadwood, South Dakota, July 22–23, 2015.

Stepan, D.J., and Hamling, J.A., 2015, Surface and shallow subsurface soil gas and water monitoring at the Bell Creek oil field: Presented to Denbury Resources Inc. personnel, Bell Creek Project Update Meeting, Plano, Texas, September 24–25, 2015.

Stepan, D.J., and Hamling, J.A., 2015, Surface and shallow subsurface soil gas and water monitoring at the Bell Creek oil field: Presented at the Bell Creek Project Update Meeting, Plano, Texas, April 13, 2015.

Poster Presentations (many of these posters were presented at more than one event) (13)

Bosshart, N.W., Braunberger, J.R., Burton-Kelly, M., Dotzenrod, N.W., and Gorecki, C.D., 2015, Multiscale reservoir modeling for CO_2 storage and enhanced oil recovery using multiple point statistics: Poster presented at the EAGE Petroleum Geostatistics 2015 Conference, Biarritz, France, September 7–11, 2015.

Braunberger, J.R., Hamling, J.A., Gorecki, C.D., Miller, H., Rawson, J., Walsh, F., Pasternack, E., Rowe, W., Butsch, R., Steadman, E.N., and Harju, J.A., 2014, Characterization and time-lapse monitoring utilizing pulsed-neutron well logging—associated CO_2 storage at a commercial CO_2 EOR project: Poster presented at the International Conference on Greenhouse Gas Technologies (GHGT-12), Austin, Texas, October 5–9, 2014.

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Glazewski, K.A., Hamling, J.A., Peck, W.D., Doll, T.E., Laumb, J.D., Gorecki, C.D., Azzolina, N.A., Nakles, D.V., Steadman, E.N., and Harju, J.A., 2014, A regional wellbore evaluation of the basal Cambrian system: Poster presented at the International Conference on Greenhouse Gas Technologies (GHGT-12), Austin, TX, Oct 5–9, 2014.

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Jensen, M.D., Schlasner, S.M., Sorensen, J.A., and Hamling, J.A., 2014, Operational flexibility of CO_2 transport and storage: Poster presented at the International Conference on Greenhouse Gas Technologies (GHGT-12), Austin, Texas, October 5–9, 2014.

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Liu, G., Peck, W.D., Braunberger, J.R., Klenner, R.C.L., Gorecki, C.D., Steadman, E.N., and Harju, J.A., 2014, Evaluation of large-scale carbon dioxide storage potential in the basal saline system in the Alberta and Williston Basins in North America: Poster presented at the International Conference on Greenhouse Gas Technologies (GHGT-12), Austin, Texas, October 5–9, 2014.

Peck, W.D., and Gorecki, C.D., 2015, Guiding MVA deployment using near-real-time history matching at the Aquistore site: Poster presented at the Transforming Technology Through Integration and Collaboration Carbon Storage R&D Project Review Meeting, Pittsburgh, Pennsylvania, August 18–20, 2015.

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Deliverables/Milestones

Draft (5)

Bosshart, N.W., Jin, L., Dotzenrod, N.W., Burnison, S.A., Ge, J., He, J., Burton-Kelly, M.E., Ayash, S.C., Gorecki, C.D., Hamling, J.A., Steadman, E.N., and Harju, J.A., 2015, Bell Creek test site – simulation report: Plains CO_2 Reduction (PCOR) Partnership Phase III draft Task 9 Deliverable D66 (update 4) executive summary for U.S. Department of Energy National Energy Technology Laboratory Cooperative Agreement No. DE-FC26-05NT42592, Grand Forks, North Dakota, Energy & Environmental Research Center, August.

Dotzenrod, N.W., Hamling, J.A., Gorecki, C.D., Steadman, E.N., and Harju, J.A., 2015, Bell Creek test site – initial analysis for first large-scale repeat pulsed-neutron logging campaign post-significant CO_2 injection completed: Plains CO_2 Reduction Partnership Phase III draft Task 9 Milestone M51 for U.S. Department of Energy National Energy Technology Laboratory Cooperative Agreement No. DE-FC26-05NT42592, Grand Forks, North Dakota, Energy & Environmental Research Center, August.

Ge, J., Burnison, S.A., Bosshart, N.W., Dotzenrod, N.W., Liu, G., Braunberger, J.R., Ayash, S.C., Hamling, J.A., Sorensen, J.A., Gorecki, C.D., Steadman, E.N., and Harju, J.A., 2015, Bell Creek Field test site – geomechanical modeling report: Plains CO_2 Reduction (PCOR) Partnership Phase III draft Task 9 Deliverable D32 (update 1) for U.S. Department of Energy National Energy Technology Laboratory Cooperative Agreement No. DE-FC26-05NT42592, Grand Forks, North Dakota, Energy & Environmental Research Center, January.

Jensen, M.D., Hamling, J.A., Gorecki, C.D., Steadman, E.N., and Harju, J.A., 2015, Bell Creek test site – transportation and injection operations report: Plains CO_2 Reduction Partnership Phase III draft Task 8 Deliverable D49 for U.S. Department of Energy National Energy Technology Laboratory Cooperative Agreement No. DE-FC26-05NT42592, Grand Forks, North Dakota, Energy & Environmental Research Center, September.

Wilson IV, W.I., Doll, T.E., and Gorecki, C.D., 2015, Permitting review – update 2: Plains CO_2 Reduction (PCOR) Partnership Phase III draft Task 3 Deliverable D8 for U.S. Department of Energy National Energy Technology Laboratory Cooperative Agreement No. DE-FC26-05NT42592, Grand Forks, North Dakota, Energy & Environmental Research Center, September.

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Liu, G., Gorecki, C.D., Bailey, T.P., Peck, W.D., and Steadman, E.N., 2014, Geologic modeling and simulation report for the Aquistore project: Plains CO_2 Reduction (PCOR) Partnership Phase III Task 1 Deliverable D93 (update 1) for U.S. Department of Energy National Energy Technology Laboratory Cooperative Agreement No. DE-FC26-05NT42592, EERC Publication 2014-EERC-11-03, Grand Forks, North Dakota, Energy & Environmental Research Center, September.

Sorensen, J.A., Botnen, L.S., Smith, S.A., Liu, G., Bailey, T.P., Gorecki, C.D., Steadman, E.N., Harju, J.A., Nakles, D.V., and Azzolina, N.A., 2014, Fort Nelson carbon capture and storage feasibility study – a best practices manual for storage in a deep carbonate saline formation:

Plains CO_2 Reduction (PCOR) Partnership Phase III Task 9 Deliverable D100 for U.S. Department of Energy National Energy Technology Laboratory Cooperative Agreement No. DE-FC26-05NT42592, EERC Publication No. 2014-EERC-11-08, Grand Forks, North Dakota, Energy & Environmental Research Center, September.

Submitted and Approved (10)

Ayash, S.C., Gorecki, C.D., Steadman, E.N., and Harju, J.A., 2015, Technical Advisory Board meeting scheduled: Plains CO_2 Reduction (PCOR) Partnership Phase III Task 13 Milestone M36 for U.S. Department of Energy National Energy Technology Laboratory Cooperative Agreement No. DE-FC26-05NT42592, EERC Publication 2015-EERC-04-02, Grand Forks, North Dakota, Energy & Environmental Research Center, March.

Daly, D.J., Crocker, C.R., Gorecki, C.D., Steadman, E.N., and Harju, J.A., 2015, General audience CO_2 sequestration outreach PowerPoint presentation: Plains CO_2 Reduction (PCOR) Partnership Phase III Task 2 Deliverable D17 (Update 6) for U.S. Department of Energy National Energy Technology Laboratory Cooperative Agreement No. DE-FC26-05NT42592, Grand Forks, North Dakota, Energy & Environmental Research Center, June.

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