Plains CO_2 Reduction (PCOR) Partnership Monthly Update
November 1–30, 2015

PHASE III ACTIVITIES

Task 1 – Regional Characterization (Wesley D. Peck)

Highlights

- Continued development of criteria for the Inyan Kara Basin model.
- Continued compiling regional characterization data for the Mission Canyon Formation.
- Continued efforts to update Deliverable (D) 81, Regional Carbon Sequestration Atlas (update), due August 31, 2016.
- Updated information and continued work on the partners-only Decision Support System (DSS) Web site:
  - Continued activities to update the content of the **PCOR Partnership general database**, including the following:
    - Updated North Dakota and Montana Petra projects with the latest general well information from each state's online resources: 122 new North Dakota wells with no new Montana wells added.
    - Updated North Dakota injection data.
    - Updated South Dakota, Saskatchewan, and British Columbia projects.
    - Continued updating Saskatchewan oil fields.
  - Continued database preventive maintenance of Petra projects.
  - Continued integrating current CO_2 storage calculations into the PCOR Partnership GIS (geographic information system).
- With regard to the **Williston Basin** CO_2 Storage Sink Relative Permeability Laboratory Characterization:
  - Continued thin-section petrographic analyses.
  - Obtained core from the Broom Creek Formation to add to the samples in the study.
  - Completed air permeability testing. Continued data reduction.
  - X-ray diffraction (XRD) data continue to be quality-checked.
  - Prepared brine solutions for relative permeability testing.
  - Worked on preparing the relative permeability system.
- With regard to the **Aquistore** project's static modeling and dynamic predictive simulations effort:
  - Injection was restarted. Daily data downloads have resumed.
  - Continued to analyze injection data for inclusion in the simulation model.
  - Continued history matching, with an attempt to correct injection rate to account for temperature effect.
  - Continued work on the draft simulation report.

- Continued fine-tuning the simulation model.

Task 2 – Public Outreach and Education (Daniel J. Daly)

Highlights

- Continued work on the draft Phase II project fact sheets. Addressed comments on the updated Phase II Northwest McGregor and Lignite fact sheets based on final internal Energy & Environmental Research Center (EERC) management review.
- Obtained the involvement of BillyJack Consulting, Inc., in development of the update of the Phase II Zama fact sheet.
- Obtained the involvement of CETER as a reviewer for the coal documentary (D22).
- In lieu of participation in the Outreach Working Group (OWG) monthly call on November 19, 2015, sent written comments on the review and update of the U.S. Department of Energy (DOE) Outreach best practices manual (BPM) and followed up with discussions with the OWG lead. The text was accepted by the OWG lead as a draft update for the Executive Summary and Section 1 of the manual. Review is continuing, and detailed comments will be provided on the remainder of the draft Outreach BPM document in December.
- Continued discussions with the Petroleum Technology Research Centre (PTRC) regarding collaboration on a paper and presentation at the Greenhouse Gas Control Technologies (GHGT)-13 Conference to be held November 14–18, 2016.
- Continued efforts with regard to the public Web site (www.undeerc.org/pcor), including the following:
  - Submitted the PCOR Partnership public Web site update content to Andrea Dunn for approval. Received approval November 20, 2015.
  - Continued preparation of content for the technical poster and "Options to Reduce CO_2" pages to be added to the PCOR Partnership public Web site.
  - Continued to update the Quest Project page on the public Web site to reflect the fact that the project will begin injection.
  - Continued working on potential content for the next round of updates for the public PCOR Partnership Web site.
  - Continued ongoing identification and repair of broken links.
- Continued collaborative efforts with Prairie Public Broadcasting (PPB), including the following:
  - Traveled to Fargo, North Dakota, for a meeting with PPB personnel and discussed Budget Period (BP) 4 extension and BP5 plans, schedules, and budget.
  - Continued work on the coal documentary (D22) transcripts, including correspondence with GCCSI regarding potential filming in China.

Task 3 – Permitting and NEPA (National Environmental Policy Act) Compliance (Charles D. Gorecki)

Highlights

- Attended the final North Dakota Department of Health public meeting on the Clean Power Plan on November 18, 2015, in Fargo, North Dakota.

- Continued gathering information for the value-added report on rules, regulations, and statutes for various scenarios of carbon capture and storage (CCS) geologic storage and for CO_2 enhanced oil recovery (EOR) for each of the PCOR Partnership states and provinces.
  - E-mailed all PCOR Partnership region regulatory contacts requesting assistance and received various e-mail responses. Spoke with a few contacts.
  - Contacted Iowa and U.S. Environmental Protection Agency (EPA) Region 7 contacts.
- Continued review of Alberta's permitting process.
- Continued work on preparing descriptor language and flowcharts of North Dakota injection well-permitting requirements.

Task 4 – Site Characterization and Modeling (James A. Sorensen)

Highlights

- **Bell Creek** test site activities included the following:
  - Continued work on the PCOR Partnership site characterization BPM (D35).
  - Continued work on the construction of regional- and basin-scale Bell Creek Muddy Formation models.
  - Continued work on comparing pulsed-neutron logging (PNL) data to history match results for oil saturations and effective porosities.
  - Continued seismic horizon interpretation in the reprocessed baseline 3-D and repeat 4-D seismic surveys and linking the Hampson–Russell outputs with the geologic modeling software (Petrel).
  - Continued work on **geomechanical modeling**, including the following:
    - Began studying the 3-D seismic AVO (amplitude variation with offset) inversion process for understanding stress regimes using the Hampson–Russell seismic processing software package.
    - Continued investigating the potential application of FLAC3D and COMSOL software to the geomechanical simulations.
    - Continued examining the functionality of Computer Modelling Group Ltd.'s (CMG's) GEM software to determine if the simulation process can be improved.
    - Continued updating the rock mechanical properties of the 3-D mechanical earth model (MEM) using log data and Petrel software.
    - Continued preparing for the geomechanical simulation work.

Task 5 – Well Drilling and Completion (John A. Hamling)

This task ended in Quarter 3 – BP4, Year 7 (June 2014).

Task 6 – Infrastructure Development (Melanie D. Jensen)

Highlights

- Attended the American Institute of Chemical Engineers (AIChE) 2015 Annual Meeting held November 9–13, 2015, in Salt Lake City, Utah. Presented a talk entitled "The Effects of Variation in CO_2 Stream Composition and Flow Rate on Enhanced Oil Recovery and Geologic Storage" based on work that was originally performed under an International Energy Agency Greenhouse Gas R&D Programme (IEAGHG) contract with DOE

cofounding, but the topic is also applicable to PCOR Partnership D45 (Bell Creek Test Site – Infrastructure Development Report), which is due March 31, 2016. The information presented in Salt Lake City will continue to be updated for inclusion in D45. The DOE project manager for the IEAGHG–DOE project approved the presentation. At the conference, sessions on CO_2 capture and geologic storage were attended.

- Began work on an updated version of the CO_2 capture technologies report. The status of 11 capture technologies was updated for inclusion in the value-added report using presentation slides from the 2015 DOE NETL capture technology meeting.
- Provided information about injection site infrastructure to another PCOR Partnership researcher.

Task 7 – CO_2 Procurement (John A. Harju)

This task ended in Quarter 4 – BP4, Year 6 (September 2013).

Task 8 – Transportation and Injection Operations (Melanie D. Jensen)

Highlights

This task ended in Quarter 4 – BP4, Year 8 (September 2015).

Task 9 – Operational Monitoring and Modeling (John Hamling/Larry Pekot)

Highlights

- Participated in the Research Partnership to Secure Energy for America (RPSEA) Interactive Workshop Focusing on Induced Seismicity held November 3–5, 2015, in Houston, Texas.
- Attended and presented at the AIChE 2015 Annual Meeting held November 9–13, 2015, in Salt Lake City, Utah.
- Attended the Carbon Management Technology Conference held November 17–19, 2015, in Sugar Land, Texas.
- Continued work on the DOE Carbon Storage Systems and Well Management BPM. The PCOR Partnership is to lead Chapter 5 – Injection Operations.
  - Participated in the DOE Carbon Storage Systems and Well Management BPM conference call. Received writing assignments and a time line for draft completion of the document by February 29, 2016. Reviewed and provided comments on draft Chapter 1.
- Held Linux training led by Guru Labs at the EERC November 2–6, 2015. The purpose of this training was to better understand the Linux operating system that is installed on the geophysics processing workstation, improving efficiency when using the workstation. Several staff members working on the Bell Creek project attended.
- Continued work on a draft of the PCOR Partnership monitoring, verification, and accounting (MVA) BPM deliverable.
- Continued work on the call-out boxes for the DOE MVA BPM.
- Attended a CMG geomechanical model coupling Webinar.
- **Bell Creek** injection-phase site activities included the following:
  - Continued repeat analyses of miscible-phase sampling of mobilized hydrocarbons using methane, CO_2, and ethane at Bell Creek reservoir conditions.

- Integrated the methane and CO_2 minimum miscibility pressure (MMP) measurements to the simulation. Different percentages of methane in CO_2 were simulated to compare oil recovery efficiency in Bell Creek Phases 1 and 2.
- Downloaded data from the 05-06 OW monitoring well recording unit.
- Continued to fine-tune the simulation case settings.
- Worked on evaluating the thermal functions of both STARS and GEM to determine the best option to simulate the impact of thermal effects on CO_2 EOR and storage.
- Worked on the new Bell Creek simulation model for development Phases 3–6, including upscaling the static model from 100 ft × 100-ft cells to 300 ft × 300-ft cells to allow faster simulation time. The model is able to run; however, simulations are slow. Numerical tuning will be performed to help the simulations run more efficiently. The model will be used for predictive simulations.
- Continued work on processing well perforation data and production history data.
- Simulated and compared ten cases for recycled gas flooding in Phase 1 and 2 areas.
- Completed the final summary of recent purchase and recycle CO_2 stream analysis results.
- Completed the fall 2015 enhanced PNL program. Successfully completed logging 17 of the 18 proposed wells.
- With regard to the November 2015 Bell Creek Field groundwater and soil gas sample event (October 26 – November 2):
  - Collected approximately 200 gas samples, 13 groundwater well parameter samples, and three water samples for laboratory analysis.
  - Continued soil gas sample analyses.
  - Continued water sample analyses.
  - Continued data processing/analysis for field readings on water samples.
  - Received confirmation of landowners' desire to continue the sampling events.
- With regard to the Bell Creek site visit November 16–20, 2015:
  - Distributed landowner results packages.
  - Met with Denbury personnel regarding future sample strategies.
  - Collected oil samples from two Phase 1 wells.
- Began development of the Bell Creek Field landowner questionnaire. The questionnaire will be used to gauge landowner feelings toward the sampling that the EERC has been conducting over the past 4 years. This will hopefully be utilized as a sales tool to move into a commercial sampling phase.
- Used the most recent publicly available data to determine that cumulative total CO_2 gas injection is 3,629,564 metric tons through September 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 98% CO_2 (Table 1).
- As of October 31, 2015, the most recent month of record, 2.632 million tonnes of total gas (composition of approximately 98% CO_2) has been purchased for injection into the Bell Creek Field, equating to an estimated 2.582 million tonnes of CO_2 stored (Table 2). 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 98% CO_2) obtained from Denbury's custody transfer meter with gas compositional data.

Table 1. Bell Creek CO_2 Gas Injection Totals for September 2015 (cumulative totals May 2013 to September 2015)*

	September 2015 Injection
Total, Mscf	3,613,337
Total, U.S. tons†	206,677
Total, metric tons†	187,677
Cumulative Total, Mscf ‡	69,879,992
Cumulative Total, U.S. tons†‡	3,997,025
Cumulative Total, metric tons†‡	3,629,564

Source: Montana Board of Oil and Gas (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.

Table 2. Cumulative Total Gas Purchased and Estimated Associated CO_2 Storage Volumes for the Bell Creek Field[1]

	October 2015 Gas Volume
Monthly Total Gas Purchased, MMscf[2]	1671
Monthly Total Gas Purchased, million tons[2]	0.096
Monthly Total Gas Purchased, million tonnes[2]	0.087
Cumulative Total Gas Purchased, MMscf[2,3]	50,677
Cumulative Total Gas Purchased, million tons[2,3]	2.899
Cumulative Total Gas Purchased, million tonnes[2,3]	2.632
Cumulative Total CO_2 Stored, MMscf[3,4]	49,712
Cumulative Total CO_2 Stored, million tons[3,4]	2.843
Cumulative Total CO_2 Stored, million tonnes[3,4]	2.582

[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.

– Continued injection-phase sampling work, including the following:
  - ♦ Traveled to Gillette, Wyoming, for near-surface sampling at the Bell Creek site October 25 – November 1, 2015.
  - ♦ Traveled to Gillette, Wyoming, for site work at the Bell Creek fields October 26 – November 5, 2015.
  - ♦ Traveled to Gillette, Wyoming for site work at the Bell Creek oil fields November 1–13, 2015.
  - ♦ Traveled to Gillette, Wyoming for site work at the Bell Creek oil fields November 16–19, 2015.

Task 10 – Site Closure (to be announced [TBA])

- This task is anticipated to be initiated in Quarter 1 – BP 5, Year 9 (April 2016).

Task 11 – Postinjection Monitoring and Modeling (TBA)

- This task is anticipated to be initiated in Quarter 1 – BP5, Year 9 (April 2016).

Task 12 – Project Assessment (Loreal V. Heebink)

Highlights

- Continued preparing the outline and text of the Project Assessment Annual Report (D57) due December 31, 2015, to fit the activities from Project Year 8.

Task 13 – Project Management (Charles D. Gorecki)

Highlights

- Met with consultants from CETER to discuss their involvement in several PCOR Partnership tasks and get updates on the progress of several ongoing efforts.
- Participated in National Risk Assessment Partnership (NRAP) beta tool Webinars (Design for Risk Evaluation and Monitoring, Wellbore Leakage Analysis Tool, and Aquifer Impact Model). We plan to test several of the beta tools and will be attending the corresponding Webinars.
- Held the second BPM writing workshop on November 10, 2015. Several EERC staff who will be working on the PCOR Partnership BPMs attended.
- Participated in the Regional Carbon Sequestration Partnership (RCSP) "Designing, Drilling, and Operating CCS Wells" BPM conference call.
- Continued planning for the spring 2016 Technical Advisory Board (TAB) meeting to be held in New Orleans, Louisiana, on April 4–6. Contacted TAB members with hotel block information.
- Continued working on the PCOR Partnership BP5 continuation application. Worked on reviewing the Gantt chart, current deliverables and milestones, statement of project objectives, and an overview presentation of BP5 activities for discussion.
- Received renewed licenses for several Schlumberger software packages.
- Held a task leader meeting November 20, 2015. Topics discussed included the BP5 continuation application, attendance at North Dakota public input meetings regarding the EPA Clean Power Plan, attendance at recent conferences and meetings, participation in NRAP Webinars, Bell Creek and Aquistore project updates, upcoming meetings/conferences, and task leader updates.
- Completed deliverables and milestones in November:
  - October monthly update

Task 14 – RCSP Water Working Group (WWG) Coordination (Ryan J. Klapperich)

Highlights

- Continued review of the articles for the special issue of *International Journal of Greenhouse Gas Control* (IJGGC) on the "Nexus of Water and Carbon Capture and Storage." Worked with a consultant from CETER on a list of potential reviewers.
- Met with a consultant from CETER to discuss the special issue of IJGGC on the Nexus of water and CCS.
- Submitted and received approval on a request to change the scope of work from working on a BPM (D80) to create and edit a special issue of IJGGC (D106).
- The November 2015 monthly conference call was rescheduled to December 2015 because of unavailability of participants.
- Prepared for the December 2015 WWG call.
- Began drafting sidebars for the DOE BPMs, and sent draft ideas to DOE.
- Revised the list of potential WWG topics for DOE BPMs, and reached out to the representatives for the BPMs.
- Worked with a consultant from CETER on an example of a callout box addition to the DOE BPMs.
- Reviewing the plan and budget for BP5 and potential for revisions.

Task 15 – Further Characterization of the Zama Acid Gas EOR, CO_2 Storage, and Monitoring Project (Charles D. Gorecki)

This task ended in Quarter 2 – BP4, Year 7 (February 2014).

Task 16 – Characterization of the Basal Cambrian System (Wesley D. Peck)

This task ended in Quarter 2 – BP4, Year 7 (March 2014).

Travel/Meetings

- October 25 – November 1, 2015: Traveled to Gillette, Wyoming, for site work at the Bell Creek oil fields.
- October 26 – November 5, 2015: Traveled to Gillette, Wyoming, for SASSA project work at the Bell Creek site.
- November 1–3, 2015: Traveled to Gillette, Wyoming, for site work at the Bell Creek oil fields.
- November 3–5, 2015: Traveled to Houston, Texas, for the Interactive Workshop Focusing on Induced Seismicity.
- November 8–13, 2015: Traveled to Salt Lake City, Utah, to attend the AICHE Annual Meeting.
- November 16–19, 2015: Traveled to Gillette, Wyoming, for site work at Bell Creek.
- November 17, 2015: Traveled to Fargo, North Dakota, to meet with Prairie Public Broadcasting production staff to work on budgets, planning, and schedules for the upcoming documentaries.

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