Plains CO_2 Reduction (PCOR) Partnership Monthly Update
December 1–31, 2016

PHASE III ACTIVITIES

Task 1 – Regional Characterization (Wesley D. Peck)

Highlights

- Submitted Deliverable (D) 81 entitled "PCOR Partnership Atlas 5th Edition" on December 30, 2016.
- Fixed broken PCOR Partnership partner links on the members-only Decision Support System (DSS) Web site. Added several recently approved reports to the DSS.
- Continued work on regional models, including gridding the Gooseneck Field.
- Continued activities to update the content of the **PCOR Partnership general database**, including the following:
  - Updated North Dakota, Montana, Nebraska, and Manitoba well and production data.
  - Continued database preventive maintenance of Petra projects.
- With regard to **Williston Basin** CO_2 Storage Sink Relative Permeability Laboratory Characterization:
  - Completed a draft of the final value-added report, due January 31, 2017.
  - Worked on the internal review of the draft value-added report.
- With regard to the **Aquistore** project's static modeling and dynamic predictive simulations effort:
  - Continued to download and process injection and pressure data as available.

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

Highlights

- Received approval from DOE for D15 Fact Sheet (update) entitled "Bell Creek Integrated CO_2 EOR and Storage Project" on December 6, 2016. However, this document has been sent to Denbury Resources Inc. (Denbury) for review. Once approved by Denbury, the U.S. Department of Energy (DOE) will have another opportunity to review and approve.
- Continued work on the value-added update of the Phase II Terrestrial Sequestration fact sheet.
- Continued work on the draft updated Phase II Zama fact sheet.
- Continued efforts with regard to the public Web site (www.undeerc.org/pcor), including the following:
  - Continued ongoing identification and repair of broken links.
- Participated in the monthly Outreach Working Group conference call on December 15, 2016. Topics discussed included suggested topics and schedule of calls for 2017.

- Continued collaborative efforts with Prairie Public Broadcasting (PPB), including the following:
  - Continued work on Documentary D22 (Coal and the Modern Age), including the following:
    - Continued script development and revision.
    - Scheduled the final interviews for January 2017 with Ed Steadman and Roy Beard, EERC.
    - Provided the draft final script to PPB for final production.
    - Traveled to Fargo, North Dakota, on December 30, 2016, for a review meeting with PPB.

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

Highlights

- Discussed comments from the ongoing review of D76, Regulatory Perspective Regarding the Geologic Storage of CO_2 in the PCOR Partnership Region, due January 31, 2017. Revised D76 based on comments.
- The Webinar entitled "Environmental Regulations under the Trump Administration" originally scheduled to be held on December 15, 2016, was rescheduled by the presenter for January 10, 2017.

Task 4 – Site Characterization and Modeling (Charles D. Gorecki)

Highlights

- Continued writing and revising text and creating figures for the PCOR Partnership Site Characterization Best Practices Manual (BPM) (D35), including Sections 1–6.
- Postponed a petrophysics training event to be led by PCOR Partnership member Eric Pasternack, Outsource Petrophysics, that had been planned for December 15–16, 2016, tentatively to February 2017. The event will be held at the Energy & Environmental Research Center (EERC) and the North Dakota Geological Survey Wilson M. Laird Core and Sample Library.
- Continued minor adaptations to the Version 3 model for Bell Creek Phase Areas 4 and 5.
- Discussed the EERC's modeling and simulation software capabilities and efforts related to the calculation of dynamic storage efficiency with a representative from the DOE National Energy Technology Laboratory (NETL). Sent a condensed version of the dynamic storage efficiency workflow used at the EERC.

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

This task ended in Quarter 3 – Budget Period (BP) 4, Year 7 (June 2014).

Task 6 – Infrastructure Development (Melanie D. Jensen)

Highlights

- Worked on the 2017 update to D85 (Opportunities and Challenges Associated with CO_2 Compression and Transportation During CCUS [carbon capture, utilization, and storage] Activities).

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)

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

Task 9 – Operational Monitoring and Modeling (John A. Hamling and Larry J. Pekot)

Highlights

- Submitted a memo on December 7, 2016, regarding official updated volumes of metric tons of CO_2 purchased for injection and metric tons of CO_2 stored at Bell Creek. As of October 31, 2016, the most recent month of record, 3.442 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 ***3.384 million tonnes of CO_2 stored*.** At the end of BP4 (March 31, 2016), 2.979 million tonnes of CO_2 had been stored.
- Received approval for Milestone (M) 52 entitled "Bell Creek Test Site – Analysis of Extended Pulsed-Neutron Log Campaign Data Completed" on December 6, 2016.
- Submitted a paper entitled "Measured Crude Oil MMPs (minimum miscibility pressures) with Pure and Mixed CO_2, Methane, and Ethane, and Their Relevance to Enhanced Oil Recovery from Middle Bakken and Bakken Shales" prepared for presentation at the Society of Petroleum Engineers (SPE) Canada Unconventional Resources Conference to be held in Calgary, Alberta, Canada, February 15–16, 2017. The paper covers work performed under the PCOR Partnership and a Bakken-related EERC project.
- **Bell Creek** injection-phase site activities included the following:
  - Continued reservoir pressure and distributed temperature monitoring of 05-06 OW (observation well) from the permanent downhole monitoring system using the casing-conveyed pressure–temperature gauges and fiber-optic distributed temperature system:
    - Near-continuous operation since April 2012.
  - Continued dynamic reservoir pressure and multiphase fluid flow simulation efforts:
    - Consistent progress since April 2011.
    - History matching is complete for Bell Creek Phase Areas 1–3. Predictive simulation is complete for Bell Creek Phase Areas 1 and 2. Long-term simulations of CO_2 migration are complete for Bell Creek Phase Areas 3–7.
    - History-matched the primary depletion stage in the Bell Creek Phase 4 area in the Version 2 geologic model.
    - Worked on debugging the simulation model based on the Version 3 geologic model.

- ♦ Improved the permeability distribution in the Phase 4 simulation model based on production data.

- Continued working with the fall 2015 4-D surface seismic data set from Bell Creek, including the following:
  - ♦ Visualization and interpretation of 4-D seismic amplitude maps with respect to the estimated CO_2 volume injected for the periods between August 2012 – October 2014 and August 2012 – September 2015.
- Continued Bell Creek microseismic data processing, including the following:
  - ♦ Initiated a numerical modeling exercise in MiVu (microseismic tool). The objective is to use synthetic events of different magnitudes to improve the data-processing workflow, location, and magnitude estimations when using real data.
  - ♦ Used available information, including vertical seismic profile (VSP) and surface seismic data and horizons, to improve the initial velocity model for microseismic event localization.
- Discussed the expanded Bell Creek pulsed-neutron log (PNL) acquisition plans with representatives from Denbury and Schlumberger and tentatively scheduled field acquisition to begin the week of January 3, 2017.
- Used the most recent publicly available data to determine that cumulative total CO_2 gas injection is 6,137,704 metric tons through October 31, 2016. 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, 2016, the most recent month of record, 3.442 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 3.384 million tonnes of CO_2 stored (Table 2), with the difference comprising other trace gases in the purchase gas stream. 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.
- Continued working with a representative from Denbury and completed the fourth round of oil sample collection from a select group of wells in Bell Creek.
- Worked with Denbury personnel to initiate the fifth round of oil sample collection from a select group of wells in the Bell Creek Field.

Table 1. Bell Creek CO_2 Gas Injection Totals for October 2016 (cumulative totals May 2013 to October 2016)[1]

	October 2016 Injection
Total, Mscf	3,621,869
Total, tons[2]	207,165
Total, tonnes[2]	188,120
Cumulative Total, Mscf[2]	118,169,212
Cumulative Total, tons[2,3]	6,759,092
Cumulative Total,tonnes[2,3]	6,137,704

Source: Montana Board of Oil and Gas (MBOG) database.

[1] 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.

[2] This was calculated utilizing a conversion of 17.483 Mscf/ton and 19.253 Mscf/tonnes.

[3] 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 2016 Gas Volume
Monthly Total Gas Purchased, MMscf[2]	1302
Monthly Total Gas Purchased, million tons[2]	0.074
Monthly Total Gas Purchased, million tonnes[2]	0.068
Cumulative Total Gas Purchased, MMscf[2,3]	66,261
Cumulative Total Gas Purchased, million tons[2,3]	3.790
Cumulative Total Gas Purchased, million tonnes[2,3]	3.442
Cumulative Total CO_2 Stored, MMscf[3,4]	65,160
Cumulative Total CO_2 Stored, million tons[3,4]	3.727
Cumulative Total CO_2 Stored, million tonnes[3,4]	3.384

[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 CO_2 stored volumes are *CORRECTED* for gas composition.

- Completed the analysis of purchase/recycle CO_2 gas samples collected from the Bell Creek Field on November 29, 2016.
- A summary of all oil and CO_2 gas stream samples collected for analyses to date is provided in Table 3.

Table 3. Oil and CO_2 Gas Stream Sampling and Analyses

		Production Stream by Development Phase, Well[1]									
Date	Purchase/	Phase 1				Phase 3			Phase 4		
Sampled	Recycle[1]	56-14R	32-02	05-06	04-04	28-02	21-10	21-14	34-09	34-07	34-03
Jan 2014		O	O	O							
Mar 2014		O	O								
May 2014	P	O	O	O							
Jun 2014	PR	O	O	O							
Jul 2014	PR	O	O	O							
Sep 2014	PR	OG	OG	O							
Oct 2014	PR	O	O								
Nov/Dec 2014		OG	OG	G							
Jan 2015			O	OG							
Mar 2015		G	G	G							
Apr 2015	PR										
Jun 2015		O	O	O							
Jul 2015	PR	G	G	G							
Sep 2015	PR										
Nov 2015		O		O							
Jan 2016	PR										
Apr/May 2016		O	O	O	O	O	O	O			
Jun/Jul 2016	PR	O		O	O	O	O	O			
Aug/Sep 2016		O	O		O	O	O	O	O		
Oct 2016				O							
Nov/Dec 2016[2]	PR	O	O	O	O	O	O	O	O	O	O

[1] P = purchase CO_2 gas stream, R = recycle CO_2 gas stream, O = produced oil stream, and G = produced CO_2 gas stream.
[2] Oil samples collected but not yet analyzed.

Task 10 – Site Closure (John A. Hamling)

Highlights

- Nothing to note at this time.

Task 11 – Postinjection Monitoring and Modeling (John A. Hamling and Larry J. Pekot)

Highlights

- Nothing to note at this time.

Task 12 – Project Assessment (Loreal V. Heebink)

Highlights

- Submitted D57 entitled "Annual Assessment Report" on December 30, 2016.

Task 13 – Project Management (Charles D. Gorecki)

Highlights

- Submitted M36 entitled "Technical Advisory Board Meeting Scheduled" on December 28, 2016.
- Continued compiling project information for the upcoming IEA Greenhouse Gas R&D Programme Fiscal Year 2017 (FY17) Regional Carbon Sequestration Partnerships (RCSP) Expert Review to be held January 23–27, 2017, in Pittsburgh, Pennsylvania. Submissions included the following:
  - Submitted the Project Technical Summary to PCOR Partnership program manager on December 9, 2016, for DOE to upload to a SharePoint site for transfer to the peer review panel.
  - Submitted the draft PowerPoint presentation to the PCOR Partnership program manager on December 21, 2016. Following review, submitted the final presentation on December 22, 2016, for DOE to upload to a SharePoint site for transfer to the peer review panel.
- Upon request, compiled and submitted a response to DOE regarding PCOR Partnership international collaboration during the October–December 2016 quarter.
- Continued working with a consultant from the CETER Group to revise the draft Adaptive Management Approach Best Practices Manual (D102), incorporating comments received from PCOR Partnership Technical Advisory Board (TAB) members. A revised final draft was completed and is undergoing additional internal review.
- Held a task leader meeting December 8, 2016. Topics discussed included preparations for the January 2017 RCSP peer review, Bell Creek and Aquistore project updates, past and upcoming conferences, upcoming training opportunities, and task leader updates.
- Continued planning for the 2017 PCOR Partnership Annual Membership Meeting. Held a meeting to discuss potential meeting locations and dates.
- Completed deliverables and milestones in December:
  - November monthly update
  - Task 1: D81 – PCOR Partnership Atlas 5th Edition
  - Task 12: D57 – Annual Assessment Report
  - Task 13: M36 – TAB Meeting Scheduled

- Task 14: D106 – Special Issue of IJGGC (*International Journal of Greenhouse Gas Control*) – Nexus of Water and Carbon Capture and Storage

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

Highlights

- Agreed to participate as a panelist for the "Science Challenges to Improve Industrial Water Use" at the DOE workshop: Basic Research Needs for the Energy–Water Nexus: New Approaches to Ensure Robust and Secure Energy and Water Systems to be held January 4–6, 2017, in North Bethesda, Maryland.
- Submitted the introductory article and recommended journal publications to IJGGC for the special issue.
- Submitted D106 entitled "Special Issue of IJGGC – Nexus of Water and Carbon Capture and Storage" on December 29, 2016.
- Continued work on a draft outline for D107 (Journal Article or Topical Report – Major Research Focuses for Water and CCS).
- Sent notes from the November 16, 2016, fall quarter WWG conference call to WWG members.

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

- December 5–6, 2016: traveled to Bismarck, North Dakota, to attend the Joint North Dakota Petroleum Council Legislative Reception.
- December 5–9, 2016: traveled to Midland, Texas, to attend and present at the 14th Annual CO_2 Conference Week.
- December 9–21, 2016; traveled to Gillette, Wyoming, to collect PNLs at the Bell Creek site.
- December 30, 2016: traveled to Fargo, North Dakota, to work on the PCOR Partnership coal documentary (D22) with PPB.

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