Plains CO_2 Reduction (PCOR) Partnership Monthly Update
February 1–28, 2017

PHASE III ACTIVITIES

Task 1 – Regional Characterization (Wesley D. Peck)

Highlights

- Received approval for Deliverable (D) 81 entitled "PCOR Partnership Atlas 5th Edition," with minor notes, on February 1, 2017. Worked on the final version, including the following:
  - Worked to ensure correct placement of text and graphics for printing and binding.
  - Worked on review of a revised printed copy. Made minor changes in the setup.
- Completed an initial internal review for content updates to the Bell Creek portion of the PCOR Partnership members-only Decision Support System (DSS) on the PCOR Partnership regional background; characterization; monitoring, verification, and accounting (MVA); and modeling/simulation activities. Content has been placed in the Web-based format and is undergoing additional review. Future activities will be focused on refining layout and presentation of site content in the Web-based format.
- Continued work on a value-added report on the geologic characterization and CO_2 storage potential of the state of Nebraska.
- Continued activities to update the content of the **PCOR Partnership general database**, including the following:
  - Updated North Dakota, South Dakota, Montana, 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:
  - Made revisions to the draft value-added report prior to additional internal review.
- With regard to the **Aquistore** project's static modeling and dynamic predictive simulations effort:
  - Worked with Petroleum Technology Research Centre (PTRC) to gain access to the cloud storage database containing Aquistore injection data. Downloaded and processed available data through February 15, 2017.
  - Worked on dipole sonic log interpretation. The data will be used to investigate the formation mechanical properties and anisotropy and estimate the stress regime and fracture direction.
  - Responded to a request from PTRC for a previously published presentation and technical report.
  - Draft of a cooperation memorandum of understanding between PTRC and the Energy & Environmental Research Center (EERC) is under review.

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

Highlights

- Worked on incorporating review comments from the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) and Denbury Onshore (Denbury) into Documentary D21 (The Bell Creek Story – CO_2 in Action).
- Discussed and modified the draft value-added update of the Phase II Terrestrial Sequestration fact sheet. Began internal review.
- Continued work on the text of the draft updated Phase II Zama fact sheet.

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

Highlights

- Nothing to note at this time.

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

Highlights

- Continued work on the PCOR Partnership Site Characterization Best Practices Manual (BPM) (D35), including the following:
  - Continued working on draft text and graphics for Section 6.1 (Phase 1 – Site Screening), Section 6.2 (Phase 2 – Feasibility), and Section 6.3 (Phase 3 – Design).
  - Continued internal review of the BPM.
  - Worked on modifications based on initial review comments.
- Conducted a 2-day petrophysics training event February 7–8, 2017, at the EERC and the North Dakota Core Library. The event was led by PCOR Partnership member Eric Pasternack, Outsource Petrophysics. The training used PCOR Partnership data sets and focused on ongoing PCOR Partnership activities.

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 D85 update (Opportunities and Challenges Associated with CO_2 Compression and Transportation during CCUS [Carbon Capture, Utilization, and Storage] Activities), including sections discussing end uses of CO_2 and their specific CO_2 stream purity requirements, removal of contaminants and relative costs, and potential pipeline changes.

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

- Attended a Linux Sysadmin Workshop held in El Segundo, California, February 9–10, 2017. This was a hands-on training workshop on Linux system administration, which will allow more efficient use of the dedicated geophysics workstation. This workstation is used for processing and analysis of seismic data.
- Two researchers attended NExT Training: Seismic Interpretation with Petrel held February 27 – March 3, 2017, in Houston, Texas.
- Worked on an abstract based on simulation work to be submitted for consideration at the 2017 American Institute of Chemical Engineers (AIChE) meeting to be held October 29 – November 3, 2017, in Minneapolis, Minnesota.
- Worked on updating the Bell Creek risk assessment based on January 2017 meeting feedback.
- **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 (DTS):
    - Near-continuous operation since April 2012.
    - Traveled to the Bell Creek Field February 22–24, 2017, to download DTS unit and MOREVision data, which included:
      - DTS data: July 11, 2016 to February 23, 2017
      - MOREVision data: July 29, 2016 to February 23, 2017
      - Encountered 18 days of lost data (July 11–29, 2016) for each of the three gauges (lower, middle, and upper) on the MOREVision unit. The data gap is attributed to sample rates being reverted back to 10-second intervals instead of 5-minute intervals according to PROMORE's updates to the program, thus causing the system to overwrite.
    - Initiated processing and data integration.
  - Continued dynamic reservoir pressure and multiphase fluid flow simulation efforts. The modeling and simulation focus remains on Bell Creek Field Phase Areas 1–4. Accomplishments and activities include the following:
    - History matching of the simulation model 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 matching of the primary depletion and water-flooding stages is complete for Bell Creek Phase Area 4 based on the Version 2 geologic model.
    - Worked on analyzing the material balance relationship between water injection and liquid production in the water-flooding stage in Bell Creek Phase Area 4 in the Version 2 geologic model.
    - Analyzed water injection and individual well injectivity in Bell Creek Phase Area 4.

    - Completed history match for the water-flooding stage in Bell Creek Phase Area 4 using the Version 3 simulation model.
- Continued work on D104 (Analysis of Expanded Seismic Campaign), including writing text for a chapter on microseismic data analysis.
- Continued 4-D seismic data analysis and interpretation, including the following:
    - Worked on integrating 4-D seismic data with pulsed-neutron logs (PNLs).
    - Worked on mapping changes in reservoir properties (Sg and pressure) to compare with the 4-D seismic map in order to update the simulation model at various well locations.
    - Worked on integrating seismic data into the Bell Creek Phases 1 and 2 combined simulation model, which will provide better saturation and pressure profiles for results comparison between simulation and seismic response.
    - Worked on integrating 4-D seismic data with vertical seismic profile (VSP) data.
- Continued Bell Creek Field microseismic data processing focused on data collected May–June 2013 and June–July 2014, including the following:
    - Worked on improving the performance of the automatic event detection algorithm available in MiVu (microseismic software).
    - Continued testing automatic event detection in MiVu.
- Applied Linux system administration skills learned in the course attended February 9–10, 2017, to improve security of the geophysics Linux workstation.
- Continued laboratory preparations for a hysteresis study to inform Version 3 simulation model parameters. Selected an initial set of samples, and performed characterization tests to be used for narrowing down the final sample set. Completed porosity and air permeability measurements on the initial sample set to use for final sample selection for flow-through testing. Determined bulk resistivity on samples prior to saturation.
- Used the most recent publicly available data to determine that cumulative total CO_2 gas injection is 6,525,890 tonnes through December 31, 2016. This value represents the total gas amount injected, which includes purchase and recycle streams and is NOT corrected for a gas composition of approximately 98% CO_2 (Table 1).

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

	December 2016 Injection
Total, Mscf	3,802,160
Total, tons[2]	217,478
Total, tonnes[3]	197,484
Cumulative Total, Mscf	125,642,959
Cumulative Total, tons[2,4]	7,186,579
Cumulative Total, tonnes[3,4]	6,525,890

Source: Montana Board of Oil and Gas (MBOG) database.
[1] Total gas injection quantities are ***NOT CORRECTED*** for gas composition and include the combined purchased and recycled gas streams.
[2] Calculated utilizing a conversion of 17.483 Mscf/ton.
[3] Calculated utilizing a conversion of 19.253 Mscf/tonnes.
[4] Cumulative totals are for the period from May 2013 to the month listed.

- As of January 31, 2017, the most recent month of record, 3.646 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 3.589 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 Denbury personnel on the fifth round of oil sample collection from a select group of wells in the Bell Creek Field.
- Continued oil composition analyses of oil samples collected from the Bell Creek oil field.
- Continued analyzing the CO_2-dominated "miscible" phase data generated for crude oil at several different pressures.
- A summary of all oil and CO_2 gas stream samples collected for analyses to date is provided in Table 3.

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

	January 2017 Gas Totals
Monthly Total Gas Purchased, MMscf[2]	1223
Monthly Total Gas Purchased, million tons[2]	0.070
Monthly Total Gas Purchased, million tonnes[2]	0.064
Cumulative Total Gas Purchased, MMscf[2,3]	70,2013
Cumulative Total Gas Purchased, million tons[2,3]	4.015
Cumulative Total Gas Purchased, million tonnes[2,3]	3.646
Cumulative Total CO_2 Stored, MMscf[3,4]	69,098
Cumulative Total CO_2 Stored, million tons[3,4]	3.952
Cumulative Total CO_2 Stored, million tonnes[3,4]	3.589

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

Table 3. Oil and CO_2 Gas Stream Sampling and Analyses

Date Sampled	Purchase/ Recycle[1]	Production Stream by Development Phase, Well[1]									
		Phase 1				Phase 3			Phase 4		
		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
Feb 2017[2]		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

- Received approval for D57 entitled “Annual Assessment Report” on February 8, 2017.

Task 13 – Project Management (Charles D. Gorecki)

Highlights

- Assigned the role of Assistant PCOR Partnership Manager to Neil Wildgust. He will be supporting each task leader and PCOR Partnership Manager Charlie Gorecki.
- Upon request from DOE, worked on filling in a form pertaining to the PCOR Partnership for the Carbon Sequestration Leadership Forum (CSLF) midyear meeting to be held April 30 – May 3, 2017.
- Continued working on the revised Adaptive Management Approach Best Practices Manual (D102). Completed addressing comments provided by PCOR Partnership Technical Advisory Board (TAB) members. This document will continue to be reviewed and finalized over the next few weeks. Once finished, the revised final version with be provided to DOE.
- Worked on updating the latest PCOR Partnership programmatic risk assessment based on January 2017 meeting feedback.
- Continued planning for the 2017 PCOR Partnership Annual Membership Meeting, including choosing the city, venue, and dates. The meeting is planned to be held October 3–5, 2017, in Minneapolis, Minnesota, at the Marquette Hotel.
- Continued planning the 2017 TAB meeting, including finalizing the hotel contract in San Francisco, California.
- Held a task leader meeting February 9, 2017. Topics discussed included the January 2017 Regional Carbon Sequestration Partnership (RCSP) peer review, planning for the 2017 annual TAB and PCOR Partnership meetings, Bell Creek and Aquistore project updates, deliverables, past and upcoming conferences, and task leader updates.
- Completed deliverables and milestones in February:
  - January monthly update

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

Highlights

- Continued work on D107 (Journal Article or Topical Report – Major Research Focuses for Water and CCS [Carbon Capture and Storage]), including the following:
  - Reviewed and discussed the expanded draft outline internally. The document will be discussed with WWG members in a WWG conference call in March 2017.
  - Prepared a draft vision statement and table of contents. Discussed draft materials with Andrea McNemar, DOE NETL.

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

- February 8–12, 2017: traveled to El Segundo, California, to attend a two-day Linux Sysadmin Workshop.
- February 22–24, 2017: traveled to Glendive, Montana, for sampling at the Bell Creek site.
- February 26 – March 4, 2017: traveled to Houston, Texas, to attend Schlumberger's "Practical Seismic Interpretation with Petrel" training with NExT.

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