Plains CO_2 Reduction (PCOR) Partnership Monthly Update
December 1–31, 2017

PHASE III ACTIVITIES

Task 1 – Regional Characterization (Wesley D. Peck)

Highlights

- Continued activities to update the content of the **PCOR Partnership partners-only Decision Support System (DSS) Web site**, including the following:
  - Completed placement of all 2017 PCOR Partnership Annual Membership Meeting and Workshop materials on the PCOR Partnership members-only DSS.
- Continued work on regional models, including the following:
  - Continued development of the Fryburg–Medora model, including digitizing logs and working on importing core data from the North Dakota Geologic Survey.
  - Continued work on the Lodgepole static model by loading wells drilled from 2009 to present as well as associated logs. Began the structural model. Working on defining facies criteria.
  - Completed history matching of cumulative oil, water, and gas production for the Gooseneck Field with an open boundary condition. Working on simulations with a closed boundary.
- With regard to **Williston Basin** CO_2 Storage Sink Relative Permeability Laboratory Characterization:
  - Worked on additional internal review of the value-added report.
- With regard to the **Aquistore** project's static modeling and dynamic predictive simulations effort:
  - Participated in a Science and Engineering Research Committee (SERC) conference call December 8, 2017. SaskPower is planning a pull-tubing workover on the injection well. The distributed temperature system devices have failed; therefore, there is currently no downhole data from the injector. Permission has been granted to continue operations. A contract between Petroleum Technology Research Centre (PTRC) and SaskPower for a 3-year extension for monitoring of the Aquistore site is nearing completion.

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

Highlights

- With regard to **Documentary Deliverable (D) 22** (Coal Powered):
  - Continued to prepare edits to finalize the product, including editing several images.
  - Completed a full detailed review of the deliverable and drafted narration changes.
  - Sent video editing instructions to Prairie Public Broadcasting (PPB).

- Sent regrets regarding the monthly Outreach Working Group conference call for December 21, 2017, but followed up, reviewed call summary, and noted action items.
- Continued work on the PCOR Partnership public Web site, including the following:
  - The following went live on December 20, 2017:
    - Added fact sheets to the "North Dakota CCS [Carbon Capture and Storage] Feasibility Study" pertaining to a Phase II CarbonSAFE (Carbon Storage Assessment and Facility Enterprise) project being conducted by the Energy & Environmental Research Center (EERC).
    - New page entitled "Nebraska CCS Pre-Feasibility Study" pertaining to a Phase I CarbonSAFE project being conducted by the EERC.
    - Updated "PCOR Partnership Regional Atlas 5th Edition, Revised," on the PCOR Partnership Regional Atlas Web page.
    - Added updated fact sheets, including Bell Creek Project – Enhanced Oil Recovery Resulting in Associated CO_2 Storage (D17) and PCOR Partnership Phase III – Demonstrating CO_2 Storage in the Northern Great Plains (D14).
  - Worked on programming needed to add video clips from "The Bell Creek Story – CO_2 in Action" to the Video Clip Library and update the "Carbon and CO_2" page in a future update.
  - Worked on the planned public Web site technical upgrade, including the following:
    - Tested the ability to play videos on HTML5.
    - Continued work on the new template for the upgrade.
    - Held several internal discussions.
- Continued work on Public Site Updates (D13) due January 31, 2018.

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

Highlights
- Worked on reviewing information needed for Update 4 of D8 Permitting Review, due February 28, 2018.

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

This task ended in Quarter 1 – Budget Period (BP) 5, Year 10 (March 2017).

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
- Nothing to note at this time.

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 the Midland CO_2 and ROZ (residual oil zone) conference held December 4–8, 2017, in Midland, Texas. Presented "Life Cycle Analysis for CCS and CCUS [Carbon Capture, Utilization, and Storage]: Lessons Learned and Changing Paradigms."
- Submitted two memos to the U.S. Department of Energy National Energy Technology Laboratory (DOE NETL) regarding official updated volumes of tonnes of CO_2 purchased for injection and tonnes of CO_2 stored at Bell Creek. At the end of BP4, 2.979 million tonnes of CO_2 had been stored.
  - Submitted a memo on December 6, 2017. As of October 31, 2017, 4.425 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 ***4.362 million tonnes of CO_2 stored***.
  - Submitted a memo on December 21, 2017. As of November 30, 2017, the most recent month of record, 4.599 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 ***4.536 million tonnes of CO_2 stored***.
- Based on mutual agreement with the DOE NETL Project Manager, the PCOR Partnership plans to submit an update to D69 (Best Practices for Modeling and Simulation of CO_2 Storage), which was submitted May 31, 2017, that incorporates additional reviewer perspectives and findings. Continued work on revisions to lessons learned, recommended best practices, case studies, and text.
- Based on mutual agreement with the DOE NETL Project Manager, the PCOR Partnership plans to submit an update to D51 (Best Practices Manual – Monitoring for CO_2 Storage), which was submitted October 31, 2017, that incorporates additional technical expert reviewer perspectives and findings. Continued work on revisions based on 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:
    - Near-continuous operation since April 2012.
  - Traveled to Bell Creek Field December 13–14, 2017, for time-lapse pulsed-neutron log (PNL) saturation log acquisition in two wells in Phase Area 4 in coordination with Denbury Onshore (Denbury) and Schlumberger. The logging was successful in one well but only partially completed in the second well.
  - 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 Phase Areas 1–3 using the simulation model based on the Version 2 geologic model. Predictive simulation is complete for Phase Areas 1 and 2. Simulations to investigate long-term CO_2 migration are complete for Phase Areas 3–7.

- History matching of the simulation model is complete for the waterflooding and CO_2-flooding stages for Phase Area 4 using the simulation model based on the Version 3 geologic model.
- Updated the simulation model with refined dates for Bell Creek Phase Area 3 to cover the time span of seismic surveys.
- Processed CO_2 saturation thickness data for all wells in Phase Area 1. The simulation results match well with the PNL data.

- Progress processing the passive seismic data set was impeded by strong 60 Hz and other monochromatic noise. A new filter module for the MiVu software from GeoTomo arrived and was installed. Processing continued with the new workflow.
- Reran the Phase Area 4 reservoir model and compared the bottomhole pressure of some wells with the simulation results.
- Continued to work with data to be used in conjunction with InSAR (interferometric synthetic aperture radar) data. Set up the geomechanical model to estimate ground surface deformation through the forward modeling process. Continued work on the pressure data history of the wells in Phase Area 4 to improve the geomechanical modeling for use in ground surface deformation modeling and simulation.
- Used the most recent publicly available data to determine that cumulative CO_2 gas injection is 8,709,344 tonnes through October 31, 2017. This value represents the total gas injected, which includes purchase and recycle streams and is NOT corrected for a gas composition of approximately 98% CO_2 (Table 1).
- As of November 30, 2017, the most recent month of record, 4.599 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 4.536 million tonnes of CO_2 stored (Table 2), with the difference comprising other trace gases in the purchase gas stream. A separate method from that used to calculate estimated total gas injected was used to calculate a cumulative associated CO_2 storage by correcting the gas purchase volume (approximately 98% CO_2) obtained from Denbury's custody transfer meter with gas compositional data.
- Contacted a Denbury representative to discuss possible additional oil sampling in Bell Creek Field.
- A summary of all oil and CO_2 gas stream samples collected for analyses to date is provided in Table 3.

Table 1. Bell Creek CO_2 Gas Injection Totals for October 2017 (cumulative totals May 2013 to October 2017)[1]

	October 2017 Injection
Total, Mscf	4,423,275
Total, tons[2]	253,004
Total, tonnes[3]	229,745
Cumulative Total, Mscf[4]	167,681,006
Cumulative Total, tons[2,4]	9,591,089
Cumulative Total, tonnes[3,4]	8,709,344

Source: Montana Board of Oil and Gas 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/tonne.

[4] 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 for the Bell Creek Field[1]

	November 2017 Gas Totals
Monthly Total Gas Purchased, MMscf [2]	3360
Monthly Total Gas Purchased, million tons[2]	0.192
Monthly Total Gas Purchased, million tonnes[2]	0.174
Cumulative Total Gas Purchased, MMscf [2,3]	88,545
Cumulative Total Gas Purchased, million tons[2,3]	5.065
Cumulative Total Gas Purchased, million tonnes[2,3]	4.599
Cumulative Total CO_2 Stored, MMscf [3,4]	87,325
Cumulative Total CO_2 Stored, million tons[3,4]	4.995
Cumulative Total CO_2 Stored, million tonnes[3,4]	4.536

[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

		Production Stream by Development Phase, Well[1]									
		Phase 1				Phase 3			Phase 4		
Date Sampled	Purchase/ 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
Feb 2017[2]		O	O		O	O	O	O	O	O	O
May 2017[2]	PR	O	O	O	O	O	O	O	O	O	O
July 2017[2]		O			O	O	O	O	O	O	O
Oct 2017				O			O	O	O	O	O
Nov 2017		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.

- Continued oil composition analyses of oil samples collected from Bell Creek Field. Completed oil samples from Phase Area 1.
- Worked on CO_2 pressure/flushing tests with Bell Creek crude oil on a sand bed to study the movement of hydrocarbons with CO_2.

Task 10 – Site Closure (John A. Hamling)

Highlights

- Submitted D54 entitled "Bell Creek Test Site – Site Closure Plan" to DOE NETL on December 28, 2017, for review. Received approval December 29, 2017.

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

Highlights

- Worked on an abstract to be submitted for consideration at Greenhouse Gas Control Technologies (GHGT)-14 to be held October 21–26, 2018, in Melbourne, Australia. The DOE NETL Project Manager approved the use of a paper to be submitted to GHGT-14 as D73 (Monitoring and Fate of Stored CO_2). The GHGT-14 paper is entitled "Applied Modeling and Monitoring of the Fate of Injected CO_2 for the Management of Geologic Storage."

Task 12 – Project Assessment (Loreal V. Heebink)

Highlights

- Submitted D57 entitled "Annual Assessment Report" on December 29, 2017, for review.

Task 13 – Project Management (Charles D. Gorecki)

Highlights

- Submitted Milestone (M) 36 entitled "Technical Advisory Board Meeting Scheduled" on December 28, 2017, for review. Received approval December 29, 2017. The 2018 Technical Advisory Board (TAB) meeting has been scheduled to be held April 9–11, 2018, in Miami, Florida.
- Submitted M65 entitled "PCOR Partnership Annual Membership Meeting and Workshop Held" on December 29, 2017, for review.
- Attended the 7th Carbon Sequestration Leadership Forum (CSLF) Ministerial Meeting held December 3–7, 2017, in Abu Dhabi, United Arab Emirates.
- Attended the Midland CO_2 and ROZ conference held December 4–8, 2017, in Midland, Texas.
- Attended the DOE NETL Regional Carbon Sequestration Partnerships (RCSPs) Permitting Lessons Learned meeting held December 12, 2017, in Washington, D.C.
- Continued work on a planned special issue of *International Journal of Greenhouse Gas Control*. Team members continued writing text for potential papers related to all active tasks. Completed Elsevier's EVISE editorial training.
- Continued to write abstracts for submission to GHGT-14 to be held October 21–26, 2018, in Melbourne, Australia. Abstracts are being written by team members from most active tasks.
- Completed reporting in December:
  - November monthly update

- Task 10: D54 – Bell Creek Test Site – Site Closure Plan
- Task 12: D57 – Annual Assessment Report
- Task 13: M36 – Technical Advisory Board Meeting Scheduled
- Task 13: M65 – PCOR Partnership Annual Membership Meeting and Workshop Held

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

Highlights

- Continued development of the draft D107 (Journal Article or Topical Report – Major Research Focuses for Water and CCS), including adding input from other partnerships. The DOE NETL Project Manager approved the use of a paper to be submitted to GHGT-14 as D107. The GHGT-14 paper is entitled "Nexus of Water and CCS: Findings of the Water Working Group (WWG) of the Regional Carbon Sequestration Partnerships."

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

- November 30 – December 7, 2017: traveled to Abu Dhabi, United Arab Emirates, to present at and attend the CSLF 7th Ministerial Meeting.
- December 3–5, 2017: traveled to Midland, Texas, to attend the CO_2 and ROZ conference.
- December 11–13, 2017: traveled to Washington D.C., to attend the DOE RCSP Permitting Meeting.
- December 12–15, 2017: traveled to Gillette, Wyoming, for fieldwork logging at the Bell Creek site.

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