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

PHASE III ACTIVITIES

Task 1 – Regional Characterization (Wesley D. Peck)

Highlights

- Submitted Milestone (M) 60 entitled "Data Submitted to EDX" on March 14, 2017, and received approval on March 16, 2017. Carbon dioxide (CO_2) injection data and oil/gas/water production data for the Bell Creek oil field were submitted to U.S. Department of Energy's (DOE's) EDX (Energy Data Exchange) system on March 9, 2017.
- Submitted the final revised Deliverable (D) 81 entitled "PCOR Partnership Atlas 5th Edition," with minor changes, on March 14, 2017. Final printed and bound copies were received at the Energy & Environmental Research Center (EERC). Copies were distributed internally and to representatives at DOE.
- Worked on performing an internal review of the Web-based format for an update to the Bell Creek portion of the PCOR Partnership members-only Decision Support System (DSS).
- 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, and Manitoba well and production data.
  - Updated Montana, Wyoming, Nebraska, and Saskatchewan well information.
  - Continued database preventive maintenance of Petra projects.
- With regard to **Williston Basin** CO_2 Storage Sink Relative Permeability Laboratory Characterization:
  - Continued 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.
  - Processed injection data from October 2016 to March 13, 2017.
  - Continued work on processing dipole sonic logs. The data will be used to investigate the formation mechanical properties and anisotropy and estimate the stress regime and fracture direction. Worked on calculating the minimum horizontal stress using the dipole sonic log and analyzing the formation anisotropy. Analyzed the stress orientation using the fracture logs available in the wells.
  - Participated in Science and Engineering Research Committee (SERC) conference calls on March 8 and 22, 2017.

– Decided with Petroleum Technology Research Centre (PTRC) that a contract agreement should be developed instead of a memorandum of understanding. PTRC and the EERC worked on the development of that contract agreement.

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

Highlights

- Submitted the value-added "Household Energy and Carbon Web Pages Report" for the October 1 – December 31, 2016, quarter on March 23, 2017.
- Participated in a Webinar entitled "Part 5: Social site characterization" hosted by the Global CCS Institute on March 23, 2017. The focus of the Webinar was social characterization as a basis for effective public engagement, education, and outreach for carbon capture and storage (CCS).
- Continued work on incorporating review comments from the U.S. DOE National Energy Technology Laboratory (NETL) and Denbury Onshore (Denbury) into Documentary D21 (The Bell Creek Story – CO_2 in Action). Worked on developing DVD components, including scenes, chapter headings, jacket, and insert.
- Continued the internal review of the draft value-added update of the Phase II Terrestrial Sequestration fact sheet. Worked on modifications based on internal review and to insert a new image on the front page.
- Continued work on the text of the draft updated Phase II Zama fact sheet, including the characterization section. Worked on internal review.
- Wrote content for CarbonSAFE project pages to be added to the CO_2 Sequestration Projects section of the public Web site in a future update. Worked on changes to the CO_2 Projects Map image to include these projects.
- Participated in the monthly Outreach Working Group (OWG) conference call on March 23, 2017. The call was focused on an OWG paper for the Carbon Capture, Utilization & Storage (CCUS) Conference to be held April 10–13, 2017, in Chicago, Illinois, and on engaging CarbonSAFE projects. Provided written comments to draft communications regarding CarbonSAFE project engagement.
- Fixed broken partner Web site links on the PCOR Partnership public Web site.

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

Highlights

- Received approval for D76 entitled "Regulatory Perspective Regarding the Geologic Storage of CO_2 in the PCOR Partnership Region" on March 23, 2017.

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

Highlights

- Submitted D35 entitled "Best Practices Manual (BPM) for Site Characterization" on March 31, 2017.
- Imported pulsed-neutron logs (PNLs) from the January campaign into the PNL Petrel model.

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 Activities), continuing to write the sections on CO_2 end uses and their purity requirements, removal of impurities 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

- Submitted two memos 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 (March 31, 2016), 2.979 million tonnes of CO_2 had been stored.
  - Submitted a memo on March 2, 2017. As of January 31, 2017, 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***.
  - Submitted a memo on March 31, 2017. As of February 28, 2017, the most recent month of record, 3.712 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 ***3.654 million tonnes of CO_2 stored***.
- Attended a Schlumberger short course entitled "Geomechanics Applications in Shale Gas" in Grand Forks, North Dakota, on March 28–29, 2017. The course covered several relevant topics, including introduction to petroleum geomechanics, construction of a Mechanical Earth Model (MEM), wellbore stability control, and shale anisotropy and heterogeneity. The knowledge will aid in the modeling process.
- Submitted and received approval for M63 entitled "Bell Creek Test Site – Initial Analysis of Processed InSAR Data Completed" on March 30, 2017.
- Discussed PCOR Partnership monitoring, verification, and accounting technology experience with a representative from Schlumberger Carbon Services for an internal DOE document.
- Continued working on content for the modeling and simulation BPM (D69), due May 31, 2017.
- Continued work on the BPM – Monitoring for CO_2 Storage and CO_2 EOR (D51), including the outline and reference resources.

- **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 (PDM) system using the casing-conveyed pressure–temperature gauges and fiber-optic distributed temperature system:
    - Near-continuous operation since April 2012.
    - Completed data processing and quality assurance/quality control for the 05-06 OW PDM data sets through February 23, 2017.
  - 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.
    - Completed the water-flooding stage history match for the Bell Creek Phase 4 area using the Version 3 simulation model.
    - Completed the CO_2-flooding stage history match for the Bell Creek Phase 4 area using the Version 3 simulation model.
  - Continued writing text for D104 (Analysis of Expanded Seismic Campaign), due June 30, 2017, including surface seismic acquisition and processing sections. Worked on crossplot analyses for inclusion.
  - Continued 4-D seismic data analysis and interpretation, including the following:
    - Worked on passive seismic processing testing event location methods.
    - Performed seismic calibration for the Bell Creek Petrel model.
    - Completed seismic well tie for four wells and generated a synthetic seismogram in the Bell Creek Petrel model. Completed six seismic horizons for the 2012 3-D seismic data using the four seismic well tie.
    - Worked with seismic prestack inversion of the repeat data set (2012 and 2014) to obtain the P-wave and S-wave velocities and impedances. This is expected to help with distinguishing saturation changes from pressure changes.
    - Completed prestack AVO (amplitude versus offset) stack inversions for the baseline and monitor.
  - Continued Bell Creek Field microseismic data processing focused on data collected May–June 2013 and June–July 2014, including the following:
    - Refined the microseismic velocity model.
  - Continued with a hysteresis study to inform Version 3 simulation model parameters, including the following:
    - Completed laboratory preparations.
    - Selected four samples for continued testing, with a low- and a high-permeability sample from each of two wells.
    - Performed laboratory tests on a trial sample and on the first study sample. Determined CO_2 permeability, brine permeability, oil permeability, and hysteresis.
    - Worked on data processing.
  - Used the most recent publicly available data to determine that cumulative total CO_2 gas injection is 6,715,451 tonnes through January 31, 2017. 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).

- As of February 28, 2017, the most recent month of record, 3.712 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 3.654 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.
- Worked with Denbury personnel on the fifth round of oil sample collection from a select group of wells in the Bell Creek Field. Nine of ten target samples were collected.
- Worked on data processing of oil composition and "miscible" phase analyses.
- 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 January 2017 (cumulative totals May 2013 to January 2017)[1]

	January 2017 Injection
Total, Mscf	3,466,679
Total, tons[2]	198,289
Total, tonnes[3]	180,059
Cumulative Total, Mscf	129,292,583
Cumulative Total, tons[2,4]	7,395,332
Cumulative Total, tonnes[3,4]	6,715,451

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.

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

	February 2017 Gas Totals
Monthly Total Gas Purchased, MMscf[2]	1261
Monthly Total Gas Purchased, million tons[2]	0.072
Monthly Total Gas Purchased, million tonnes[2]	0.066
Cumulative Total Gas Purchased, MMscf[2,3]	71,464
Cumulative Total Gas Purchased, million tons[2,3]	4.088
Cumulative Total Gas Purchased, million tonnes[2,3]	3.712
Cumulative Total CO_2 Stored, MMscf[3,4]	70,351
Cumulative Total CO_2 Stored, million tons[3,4]	4.024
Cumulative Total CO_2 Stored, million tonnes[3,4]	3.654

[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	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

- Began work on the BP5 program year (PY) 10 annual report.

Task 13 – Project Management (Charles D. Gorecki)

Highlights

- Attended the Southeast Regional Carbon Sequestration Partnership (SECARB) 12th Annual Stakeholders' Briefing held March 8–9, 2017, in Atlanta, Georgia. Presented "Lasting Impacts of the Plains CO_2 Reduction (PCOR) Partnership Program" on March 8, 2017.
- Attended and presented "The Plains CO_2 Reduction (PCOR) Partnership Program Update" to the CCUS Working Group at the North American Energy Ministers Trilateral (NAEMT) Meeting/Workshop, held March 28–30, 2017, in Pittsburgh, Pennsylvania.
- Submitted a form pertaining to the PCOR Partnership on March 10, 2017, for the Carbon Sequestration Leadership Forum (CSLF) midyear meeting to be held April 30 – May 4, 2017, upon request from DOE.
- Responded to a DOE request to provide an update on international participation during the January–March 2017 quarter, ongoing, and in the future.
- Continued addressing reviewer comments on the revised Adaptive Management Approach Best Practices Manual (D102).
- Continued planning for the 2017 PCOR Partnership Annual Membership Meeting, including working on the selection of a different venue and dates.
- Continued planning the 2017 Technical Advisory Board (TAB) meeting, including:
  - Sent meeting information to the TAB members.
  - Worked on a draft agenda.
  - Added an addendum to the hotel contract.
  - Worked with the hotel to ensure TAB members are registered.
  - Determined EERC attendees.
- Continued working on a presentation for the North American Energy Ministers Trilateral Meeting/Workshop, which will be held March 28–30, 2017, in Pittsburgh, Pennsylvania.
- Completed deliverables and milestones in March:
  - February monthly update
  - Task 1: M60 – Data Submitted to EDX
  - Task 4: D35 – Best Practices Manual (BPM) for Site Characterization

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), including the following:
  - Incorporated Andrea McNemar's, DOE NETL, comments.
  - Updated the draft for distribution to the WWG.
  - Worked on the introduction and background sections.
- Held the quarterly WWG conference call on March 30, 2017. Agenda items included discussion of the draft outline of D107, suggestions for an annual meeting speaker, and partnership updates.
- Reviewed the WWG Web site to identify necessary updates. Began preparing text related to the *International Journal of Greenhouse Gas Control* (IJGGC) effort.

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 26 – March 4, 2017: traveled to Houston, Texas, to attend Schlumberger Next Training "Practical Seismic Interpretation with Petrel."
- March 5–9, 2017: Traveled to Atlanta, Georgia, to attend the SECARB 12th Annual Stakeholders' Briefing.
- March 28–31, 2017: traveled to Pittsburgh, Pennsylvania, to attend the NAEMT CCUS Working Group Meeting and Energy Week 2017.

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