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

PHASE III ACTIVITIES

Task 1 – Regional Characterization (Wesley D. Peck)

Highlights

- Submitted Deliverable (D) 81 entitled "PCOR Partnership Atlas Update" on August 31, 2017, for review. Once approved, the PCOR Partnership Atlas 5th Edition Revised will be available on the public Web site and the partners-only Decision Support System (DSS) Web site. At this time, there is no plan to print hard copies.
- Continued work on the yearly review of the CO_2 sources data set for D1 (Review of Source Attributes [update]), including downloaded CO_2 emission updates from sources in the PCOR Partnership region, which will be incorporated into the database.
- Updated information and continued work on the partners-only DSS Web site, including the following:
  - Prepared files for the 2015 and 2016 PCOR Partnership Annual Membership Meeting pages under the PCOR Partnership Annual Meetings section.
  - The 2016 PCOR Partnership Annual Membership Meeting pages went live August 25, 2017.
- Continued activities to update the content of the **PCOR Partnership general database**, including the following:
  - Updated North Dakota, South Dakota, Montana, Nebraska, Wyoming, Manitoba, and Saskatchewan well information.
  - Continued database preventive maintenance of Petra projects.
- Continued internal review and modifications on a value-added report on the geologic characterization and CO_2 storage potential of the state of Nebraska.
- With regard to **Williston Basin** CO_2 Storage Sink Relative Permeability Laboratory Characterization:
  - Continued internal review and subsequent revisions to the draft value-added report.
- With regard to the **Aquistore** project's static modeling and dynamic predictive simulations effort:
  - Participated in Science and Engineering Research Committee (SERC) conference calls on August 2 and 23, 2017. Highlights included that SaskPower's Boundary Dam Power Station is not currently sending CO_2 to the Aquistore site. Intermittent CO_2 supplies are consistent with the normal operations of the power plant.
  - Created two posters for presentation at the Aquistore Project 2017 Annual General Meeting to be held September 12–13, 2017, in Ottawa, Ontario, Canada. Delivered electronic versions to Petroleum Technology Research Centre (PTRC).

- Advised PTRC project manager, Erik Nickel, that the draft simulation report has been with PTRC for 30 days. The PCOR Partnership is awaiting PTRC comments to make modifications prior to submitting D93 – Geological Modeling and Simulation Report for the Aquistore Project to the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL).

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

Highlights

- Held a conference call with Prairie Public Broadcasting (PPB) on August 28, 2017, to discuss regional and national distribution of Documentary D21 (The Bell Creek Story – CO_2 in Action) to public television markets via the National Educational Telecommunications Association (NETA). PPB will initiate the paperwork and prepare the materials for submittal to NETA. PCOR Partnership Task 2 personnel will contact partners to request they contact their local public television markets to request that the D21 product be aired. D21 video clip completion was also discussed.
- Held a conference call with PPB on August 28, 2017, to discuss the path forward for finalizing draft Documentary D22 (Coal Powered). A time line has been established for postproduction, with the broadcast date in the first quarter of 2018.
- Scheduled a Lunch-n-Learn viewing of draft Documentary D22 (Coal Powered) for Energy & Environmental Research Center (EERC) staff on September 12, 2017, over the lunch hour. Staff will have the opportunity to comment after the viewing.
- Began revisions to the Phase III PCOR Partnership General Fact Sheet (D14).
- Participated in the monthly Outreach Working Group conference call on August 24, 2017. An update was provided on the progress for planning for and securing a speaker for the September 21, 2017, conference call.
- Continued work on the PCOR Partnership public Web site, including content updates and preparation for Web site format on the following pages:
  - Home page
  - Aquistore Project
  - Boundary Dam Project
  - Climate, CO_2, and Sequestration
  - Weyburn–Midale
  - Fort Nelson
  - Basal Cambrian
  - CO_2 Sequestration Projects
  - North Dakota CarbonSAFE (Carbon Storage Assurance and Facility Enterprise)
  - Carbon and CO_2 on Earth – Things Have Changed!
  - CO_2 Sources
  - Greenhouse Effect
  - Climate Change

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)

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

- Attended the DOE NETL CO_2 Technologies Conference held in Pittsburgh, Pennsylvania, August 21–25, 2017.
- Reviewed existing capture technology information for possible use in the update of the final version of the CO_2 capture technologies overview value-added document.
- Upon request from a PCOR Partnership partner, examined capture, pipeline, storage, and monitoring, verification, and accounting costs used by the FACETS model to verify the validity of the data. The FACETS model contains unit-level retrofit data, data for new units, and data for storage and transport costs that can be used to indicate the economic viability of applying carbon capture and storage (CCS) to a particular plant or set of plants.

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 August 7, 2017, regarding official updated quantities of CO_2 purchased for injection and CO_2 stored at Bell Creek. As of June 30, 2017, the most recent month of record, 4.017 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 ***3.956 million tonnes of CO_2 stored***. At the end of BP4, 2.979 million tonnes of CO_2 had been stored.
- Submitted the executive summary of D66 entitled "Bell Creek Test Site – Simulation Report (Update 6)" on August 30, 2017. The report is under concurrent review by Denbury Onshore (Denbury) and may contain confidential material. If deemed not confidential, the client-approved version will be submitted upon completion of Denbury's review.
- Continued work on the best practices manual – Monitoring for CO_2 Storage and CO_2 Enhanced Oil Recovery (EOR) (D51), including revising and adding text.
- Based on mutual agreement with the DOE 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.

- Initiated planning for upload of PCOR Partnership data to NETL's Energy Data eXchange (EDX) in 2018.
- **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 (P–T) gauges and fiber-optic distributed temperature system:
    - Near-continuous operation since April 2012.
    - Traveled to Bell Creek Field August 15–17, 2017, to download data from the PDM system. Updated the sampling rate and software recording P–T data.
    - Completed processing downloaded PDM data through August 16, 2017.
  - Continued dynamic reservoir pressure and multiphase fluid flow simulation efforts. The modeling and simulation focus remains on Bell Creek oil field Phase Areas 1–4. Accomplishments and activities include the following:
    - History matching of the simulation model is complete for Phase Areas 1–3. Predictive simulation is complete for Phase Areas 1 and 2. Long-term simulations of 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.
    - Designed more simulation cases to investigate the associated CO_2 storage performance in Bell Creek with different scales and various operational conditions.
  - Ran simulation cases to investigate the effects of relative permeability hysteresis and CO_2 solubility on CO_2 EOR and associated storage in the CO_2-flooding process.
  - Worked on integrating seismic data into the Bell Creek Phases 1 and 2 long-term simulation model.
  - Extracted seismic attributes from the different seismic data (2012–2014).
  - Continued work with InSAR (interferometric synthetic aperture radar) data. The current data in house are from June to December 2016.
  - Final InSAR monitoring results are expected in September 2017 from TRE Canada.
  - Used the most recent publicly available data to determine that cumulative CO_2 gas injection is 7,726,668 tonnes through June 30, 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 June 30, 2017, the most recent month of record, 4.017 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 3.956 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.
  - Received samples from the seventh round of oil sample collection from a select group of wells in the 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 June 2017 (cumulative totals May 2013 to June 2017)[1]

	June 2017 Injection
Total, Mscf	4,051,779
Total, tons[2]	231,755
Total, tonnes[3]	210,449
Cumulative Total, Mscf[4]	148,761,547
Cumulative Total, tons[2,4]	8,508,926
Cumulative Total, tonnes[3,4]	7,726,668

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]

	June 2017 Gas Totals
Monthly Total Gas Purchased, MMscf[2]	1499
Monthly Total Gas Purchased, million tons[2]	0.086
Monthly Total Gas Purchased, million tonnes[2]	0.078
Cumulative Total Gas Purchased, MMscf[2,3]	77,331
Cumulative Total Gas Purchased, million tons[2,3]	4.423
Cumulative Total Gas Purchased, million tonnes[2,3]	4.017
Cumulative Total CO_2 Stored, MMscf[3,4]	76,168
Cumulative Total CO_2 Stored, million tons[3,4]	4.357
Cumulative Total CO_2 Stored, million tonnes[3,4]	3.956

[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]									
	Purchase/	Phase 1				Phase 3			Phase 4		
Date 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
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

[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

- Cancelled Internet service and began decommissioning of passive seismic array at Bell Creek oil field.
- Developed decommission plan/schedule for EERC mobile operations support trailers located in the field.

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

Highlights

- Revised draft outline for D73 (Monitoring and Modeling Fate of Stored CO_2).

Task 12 – Project Assessment (Loreal V. Heebink)

Highlights

- Continued updating sections in the BP5 Program Year 10 annual report based on deliverables and milestones.

Task 13 – Project Management (Charles D. Gorecki)

Highlights

- Submitted D103 entitled "PCOR Partnership Best Practices Manual for Subsurface Technical Risk Assessment of Geologic CO_2 Storage Projects" on August 29, 2017, for review.
- Attended the 2017 Mastering the Subsurface Through Technology Innovation, Partnerships and Collaboration: Carbon Storage and Oil and Natural Gas Technologies Review Meeting held August 1–3, 2017, in Pittsburgh, Pennsylvania, and presented "Bell Creek Field Project – Plains CO_2 Reduction Partnership."
- Completed preparation of the presentation entitled "The Plains CO_2 Reduction (PCOR) Partnership: Successes Leading to New Innovation" to be given at the European Association of Geoscientists and Engineers (EAGE) Technical Programme of the Fourth Sustainable Earth Sciences Conference to be held September 3–7, 2017, in Malmö, Sweden.
- Continued work on a planned special issue of *International Journal of Greenhouse Gas Control*. Created a list of potential papers (see Appendix A).
- Continued planning for the PCOR Partnership Annual Membership Meeting and Workshop, including:
  - Held a planning meeting on August 8, 2017, to discuss potential speakers and agenda development for workshop and meeting, evening events, booths and posters, sponsorships, participation promotional items, and side meetings.
  - Continued development of the draft meeting agenda.
  - Continued development of the workshop agenda and interactive activity.
  - Traveled to Plano, Texas, August 21–22, 2017, to conduct a site visit in of the hotel and off-site venues for an evening networking social and an evening event.
  - Contacted several possible venues in Plano, Texas, to inquire about pricing for special events.
  - Held a planning meeting on August 31, 2017, to discuss audiovisual needs, side meetings, agenda status, evening event updates, workshop updates, participation promotional item status, booths and posters, pioneer awards, and special event sponsors.
  - Continued evening event planning.
  - Ordered participation promotional items.
- Worked on planning a Technical Advisory Board (TAB) meeting in conjunction with the PCOR Partnership Annual Membership Meeting and Workshop.
- Held a task leader meeting August 24, 2017. Topics discussed included deliverables, planned journal articles and conference papers, site decommissioning, planning for the 2017 PCOR Partnership Annual Membership Meeting and Workshop, and task updates.
- Completed deliverables and milestones in August:
  - July monthly update
  - Task 1: D81 – PCOR Partnership Atlas Update
  - Task 9: D66 – Bell Creek Test Site – Simulation Report (Update 6) executive summary

- Task 13: D103 – PCOR Partnership Best Practices Manual for Subsurface Technical Risk Assessment of Geologic CO_2 Storage Projects

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

Highlights

- Held the WWG Annual Meeting on August 2, 2017, in Pittsburgh, Pennsylvania. The meeting hosted two guest speakers. Dale Skoff, Tetra Tech, discussed potential wastewater injectivity in western Pennsylvania and Omkar Lokare, University of Pittsburgh, discussed quantity and quality of produced waters generated in western Pennsylvania and how these change over a well's life cycle.
- Continued development of the draft D107 (Journal Article or Topical Report – Major Research Focuses for Water and CCS). Received approval of the draft outline from Andrea McNemar. Continued developing and revising content for the first three sections. Requested input from WWG members. Anticipate submitting abstract to Greenhouse Gas Control Technologies (GHGT)-14 and will create a final product that conforms to typical GHGT paper requirements.

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

- July 31 – August 4, 2017: traveled to Pittsburgh, Pennsylvania, to attend and present at the Mastering the Subsurface: Carbon Storage & Oil & Natural Gas Technologies Review meeting and to host the WWG Annual Meeting.
- August 15–17, 2017: traveled to Miles City, Montana, for a Bell Creek site visit.
- August 20–25, 2017: traveled to Pittsburgh, Pennsylvania, to attend the DOE NETL Capture Technology Project Review Meeting.
- August 21–22, 2017: traveled to Plano, Texas, to conduct a hotel site visit and evening event venue site visits for the upcoming PCOR Partnership Annual Membership Meeting.

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