Plains CO_2 Reduction (PCOR) Partnership Monthly Update
October 1–31, 2015

PHASE III ACTIVITIES

Task 1 – Regional Characterization (Wesley D. Peck)

Highlights

- Attended the Midwest Regional Carbon Sequestration Partnership (RCSP) Partners Meeting in Columbus, Ohio, October 20–22, 2015.
- Continued development of criteria for Inyan Kara Basin model.
- Continued compiling regional characterization data for the Mission Canyon Formation.
- Continued efforts to update Deliverable (D)81, Regional Carbon Sequestration Atlas (update), due August 31, 2016, including organizing information/text for new pages to be added and reworking/writing pages for specific projects, including Bell Creek, basal Cambrian/Cambro-Ordovician, and Aquistore, and revisiting pages that need figures/statistics updated.
- Updated information and continued work on the partners-only Decision Support System (DSS) Web site:
  - Continued activities to update the content of the **PCOR Partnership general database**, including the following:
    - Updated North Dakota and Montana Petra projects with the latest general well information from each state's online resources: 128 new North Dakota wells and three new Montana wells added.
    - Updated North Dakota injection data. Imported additional LAS (log ASCII standard) logs from newer North Dakota wells.
    - Updated Montana producing formation data.
    - Updated South Dakota, Saskatchewan, British Columbia, and Manitoba projects.
  - Continued database preventive maintenance of Petra projects.
  - Continued work on Saskatchewan oilfield update for the DSS.
  - Began integrating current CO_2 storage calculations into the PCOR Partnership GIS (geographic information system).
- With regard to the **Williston Basin** CO_2 Storage Sink Relative Permeability Laboratory Characterization:
  - Continued thin-section petrographic analyses.
  - Completed bulk volume determination of the core plugs using a 3-D scanner.
  - Continued air permeability testing.
  - X-ray diffraction (XRD) data continue to be quality-checked.
  - Continued porosity measurements.
  - Continued mercury injection capillary pressure (MICP) testing.

- With regard to the **Aquistore** project's static modeling and dynamic predictive simulations effort:
  - Acquired a depth-converted 3-D baseline seismic dataset for the Aquistore site, which will be used to adapt and update our existing Aquistore model.
  - Continued work on the draft simulation report.
  - Worked on variables in modeling.
  - Held a monthly internal Aquistore update meeting to discuss the progress of activities.
  - Gained access to the baseline 3-D seismic data to be incorporated in modeling efforts and began preliminary geologic interpretation for the Winnipeg Group and Deadwood Formation.
  - Continued to update database with daily injection data from PTRC (Petroleum Technology Research Centre).
  - Continued updating the simulation model. Used Computer Modelling Group (CMG) software to run simulations.
  - Continued investigating potential options (e.g., stimulation) to increase injectivity.
  - Continued work on comparing properties in the static model with the history-matched simulation model properties. The purpose is to compare the two models to ensure changes made to achieve a history match make sense with known geologic data.

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

Highlights

- Hosted a Webinar on October 29, 2015, to discuss the D21 documentary "The Bell Creek Story" with Denbury Resources.
- Continued work on the draft Phase II project fact sheets. The Energy & Environmental Research Center (EERC) PCOR Partnership managers continued final review of the updated Phase II Northwest McGregor and Lignite fact sheets.
- Continued review of the 2015 edition RCSP outreach and education best practices manual (BPM) draft. On October 22, 2015, participated in an OWG (Outreach Working Group) conference call to discuss comments and plan next steps.
- Continued discussions with PTRC regarding collaboration on a paper and presentation at the Greenhouse Gas Control Technologies (GHGT)-13 Conference to be held November 14–18, 2016.
- Continued efforts with regard to the public Web site (www.undeerc.org/pcor), including the following:
  - Reviewed the draft final of the update for the PCOR Partnership public Web site and addressed comments.
  - Continued preparation of content for the technical poster page to be added to the PCOR Partnership public Web site.
  - Replied to Save on Energy Web site regarding a link with the Kids Only page on the PCOR Partnership Web site.
  - Initiated activities to update the Quest Project page on the public Web site to reflect the fact that the project will begin injection.
  - Continued working on potential content for the next round of updates for the public PCOR Partnership Web site.
  - Continued ongoing identification and repair of broken links.

- Continued collaborative efforts with Prairie Public Broadcasting (PPB), including the following:
  - Traveled to Beulah, North Dakota, for an interview video shoot at Dakota Gasification Company and the Freedom Mine for Documentary D22.
  - Reviewed draft education video series (Parts 3 and 4) with PCOR Partnership managers.

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

Highlights

- Attended the IOGCC (Interstate Oil and Gas Compact Commission) Annual Meeting in Oklahoma City, Oklahoma, September 26 – October 1, 2015.
- Continued gathering information for value-added report on rules, regulations, and statutes for various scenarios of carbon capture and storage (CCS) geologic storage and for CO_2 enhanced oil recovery (EOR) for each of the PCOR Partnership states and provinces. Continued searching PCOR Partnership states and provinces for contact information for oil and natural gas and carbon capture, use, and storage regulators.
- Continued work on preparing descriptor language and flowcharts of North Dakota injection well permitting requirements.
- Participated in Shell Canada Webinar entitled "Building Social License and a Regulatory Framework: The Quest CCS Project."

Task 4 – Site Characterization and Modeling (James A. Sorensen)

Highlights

- **Bell Creek** test site activities included the following:
  - Continued work on the PCOR Partnership site characterization BPM (D35).
  - Worked on callout boxes for DOE's site characterization BPM.
  - Continued working on the construction of regional and basin-scale Bell Creek Muddy Formation models.
  - Continued work on **geomechanical modeling**, including the following:
    - Began investigating the potential application of FLAC3D and COMSOL software to the geomechanical simulations.
    - Began examining the functionality of CMG's GEM software to determine if the simulation process can be improved.
    - Continued updating the rock mechanical properties of the 3-D MEM using log data and Petrel software.
    - Continued preparing for the geomechanical simulation work.
    - Continued work on comparing pulsed-neutron logging (PNL) data to history-match results for oil saturations and effective porosities.
    - Continued seismic horizon interpretation in the reprocessed baseline 3-D and repeat 4-D seismic surveys and linking the Hampson–Russell outputs with the geologic modeling software (Petrel).

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

- Prepared a PowerPoint presentation for the AIChE (American Institute of Chemical Engineers) annual meeting to be held in Salt Lake City, Utah, November 8–13, 2015. A paper about the effects of CO_2 stream variable composition and mass flow rate on EOR and geologic storage will be presented in the "Novel Approaches to CO_2 Utilization" session.
- Submitted a value-added report entitled "Assessing Temporary Storage Options to Manage Variable-Rate CO_2 Emissions for Use During Enhanced Oil Recovery." Following U.S. Department of Energy (DOE) review, the authors plan to submit the manuscript for possible publication in *Energy & Environmental Science*.

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)

Highlights

- This task ended September 30, 2015.

Task 9 – Operational Monitoring and Modeling (John Hamling/Larry Pekot)

Highlights

- Continued work on a draft of the PCOR Partnership monitoring, verification, and accounting (MVA) BPM.
- Gathered information for the PCOR Partnership call-out boxes for DOE's MVA BPM.
- Reviewed and submitted comments to working group for Introduction chapter on the DOE Carbon Storage Systems and Well Management BPM.
- Initiated detailed planning and scope of work for Bell Creek life cycle assessment. The EERC will lead this effort with support from a consultant at The CETER Group.
- **Bell Creek** injection-phase site activities included the following:
  - Initiated fall 2015 enhanced PNL program. Anticipate logging 18 wells.
    - ♦ Held multiple conference calls with the Denbury Operations Team and Schlumberger Logging Team to discuss and plan field operations for this upcoming campaign.
    - ♦ Hosted a strategic operations planning meeting and WebEx in conjunction with Denbury's Bell Creek operations/productions engineering team, Schlumberger operations and service quality teams, and EERC oilfield and operations management teams to develop and modify a standard operating procedure (SOP) for the fall 2015 enhanced PNL campaign. This SOP was developed to ensure service quality and mitigate the tighter clearance in some of the wells that will be logged by following ALARA (as low as reasonably achievable) principles regarding operational risk.

    - ♦ As of October 31, 2015, successfully completed four of the 18 wells.
    - ♦ Wellsite management for Denbury, Schlumberger, and the EERC will be active for this campaign to better ensure quality of service in compliance with SOP.
- Oil samples were authorized by Denbury to be shipped from Houston to the EERC for use in a hysteresis study to be performed on core plugs from wells 33-14, 56-14, and/or 05-06 OW.
- Continued repeat analyses of miscible-phase sampling of mobilized hydrocarbons using methane, CO_2, and ethane at Bell Creek reservoir conditions.
- Continued mixing methane–CO_2 ratios to fill in the gaps in the related minimum miscibility pressure (MMP) experiments.
- Successfully installed replacement PROMORE 05-06 OW pressure–temperature gauge interrogator (part of the permanent downhole monitoring system), which was necessary because of communication issues while data were downloaded. Will send the interrogator that was replaced back to PROMORE as an exchange, and they will download and send the data from the replaced unit.
- Worked on analyzing 3-D seismic data, including creating difference maps and preparing for joint 4-D inversion using the baseline and monitoring datasets.
- Worked on simulation cases in the updated Phases 1 and 2 combined model update.
- Began preparing a Phase 3-7 dynamic model (from V2 full-field model) for predictive simulations.
- Continued work on processing well perforation data and production history data.
- Completed processing completion and production/injection data for Phase 6.
- Remotely restarted the passive seismic monitoring system after a crash. System is currently up and running.
- Used the most recent publicly available data to determine that cumulative total CO_2 gas injection is 3,629,564 metric tons through September 30, 2015. This value represents the total gas volume injected which includes purchase and recycle streams and is NOT corrected for a gas composition of approximately 96% CO_2 (Table 1).

Table 1. Bell Creek CO_2 Gas Injection Totals for September 2015 (cumulative totals May 2013 to September 2015)*

	September 2015 Injection
Total, Mscf	3,613,337
Total, U.S. tons†	206,677
Total, metric tons†	187,677
Cumulative Total, Mscf ‡	69,879,992
Cumulative Total, U.S. tons†‡	3,997,025
Cumulative Total, metric tons†‡	3,629,564

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

* 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.

† This was calculated utilizing a conversion of 17.483 Mscf/U.S. ton and 19.253 Mscf/metric ton.

‡ Cumulative totals are for the period from May 2013 to the month listed.

– As of July 31, 2015, the most recent month of record, 2.383 million tonnes of total gas (composition of approximately 96% CO_2) has been purchased for injection into the Bell Creek Field, equating to an estimated 2.301 million tonnes of associated CO_2 storage (Table 2). 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 96% CO_2) obtained from Denbury's custody transfer meter with gas compositional data.
– Continued injection-phase sampling work, including the following:
  ♦ Traveled to Gillette, Wyoming, for near-surface sampling at the Bell Creek site, October 25 – November 1, 2015.
  ♦ Completed analysis of the purchase and recycle gas stream samples collected September 16–17, 2015. Four samples from the purchase gas stream and four samples from the recycle gas stream were collected to investigate short-term variability in the injected gas composition in order to provide improved gas composition estimates for calculating CO_2 storage volumes.
  ♦ Activities completed from the annual full-field near-surface monitoring event (August 24–28, 2015):
    - Completed the soil gas data compilation and quality assurance/quality control.
    - Completed, reviewed, and printed/bound the landowner groundwater results packages for the August 2015 sample event and provided to Denbury for review.

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

	July 2015 Gas Volume
Monthly Total Gas Purchased, MMscf[2]	1928
Monthly Total Gas Purchased, million tons[2]	0.110
Monthly Total Gas Purchased, million tonnes[2]	0.100
Cumulative Total Gas Purchased, MMscf[2,3]	45,876
Cumulative Total Gas Purchased, million tons[2,3]	2.624
Cumulative Total Gas Purchased, million tonnes[2,3]	2.383
Cumulative Total CO_2 Stored, MMscf[3,4]	44,299
Cumulative Total CO_2 Stored, million tons[3,4]	2.534
Cumulative Total CO_2 Stored, million tonnes[3,4]	2.301

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

Task 10 – Site Closure (to be announced [TBA])

- This task is anticipated to be initiated in Quarter 1 – BP 5, Year 9 (April 2016).

Task 11 – Postinjection Monitoring and Modeling (TBA)

- This task is anticipated to be initiated in Quarter 1 – BP5, Year 9 (April 2016).

Task 12 – Project Assessment (Loreal V. Heebink)

Highlights

- Began drafting the outline and text of the Project Assessment Annual Report (D57) due December 31, 2015.

Task 13 – Project Management (Charles D. Gorecki)

Highlights

- Participated in National Risk Assessment Partnership (NRAP) beta tool Webinars (IAM-CS model, NSealR, and REV tool). We plan to test several of the beta tools and will be attending the corresponding Webinars.
- Participated in the DOE BPMs' synergistic Webinar with BPM leads from DOE and other partnerships.
- Sent out the press release regarding PCOR Partnership 2015 Pioneer Award winners.
- Continued planning for the spring 2016 Technical Advisory Board meeting, including finding hotel options and finalizing dates.
- Submitted notification that the co-task leaders for Task 9 are John Hamling and Larry Pekot.
- Met to discuss the PCOR Partnership BP5 continuation application.
- Continued revising the project management plan accordingly for the BP4 extension.
- Held a task leader meeting October 9, 2015. Topics discussed included a recap of the PCOR Partnership Annual Meeting, the BP4 extension, the Shell Quest project, the PCOR Partnership BPMs, upcoming NRAP Webinars, Bell Creek and Aquistore project updates, upcoming meetings/conferences, and task leader updates.
- Completed deliverables and milestones in September:
  - September monthly update
  - Task 13: D58/D59 – Quarterly Progress Report/Milestone Quarterly Report
  - Task 14: M23 – Monthly WWG Conference Call Held

Task 14 – Regional Carbon Sequestration Partnership (RCSP) Water Working Group (WWG) Coordination (Ryan J. Klapperich)

Highlights

- Most of the articles for the special issue of *International Journal of Greenhouse Gas Control* (IJGGC) on the "Nexus of Water and Carbon Capture and Storage" have been submitted. A couple of authors have requested a brief extension; the EERC is working with Elsevier to accommodate that. Reviewed submissions and assigned editors.
- With regard to special journal of IJGGC, discussed peer review process with a consultant from The CETER Group and made preliminary editor assignments.
- Continued development of draft paper for the special journal issue of IJGGC on behalf of the WWG.
- Held the monthly conference call on October 29, 2015. Discussed the list of topics/ideas for the DOE BPM additions, the plan and time line for developing the additions, and the status of submissions for the special journal of IJGCC on the Nexus of Water and CCS and the plan for the review process.

- Continued review of DOE BPMs for inclusion of water-focused material. Prepared one-page draft/example document for the site characterization BPM. Continued work on water-focused sidebars. Discussed potential ideas with a consultant from The CETER Group.

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

- September 26 – October 1, 2015: traveled to Oklahoma City, Oklahoma, to attend the IOGCC Annual Meeting.
- September 27 – October 1, 2015: traveled to Southampton, United Kingdom, to present at the IEAGHG Risk Management & Environmental Research Combined Network Meetings.
- October 20–22, 2015: Traveled to Columbus, Ohio, to attend the MRCSP Partners Meeting.
- October 21–22, 2015: Traveled to Beulah, North Dakota, for an interview and filming at the Dakota Gasification Company and the Freedom Mine.
- October 25 – November 1, 2015: Traveled to Gillette, Wyoming, for site work at the Bell Creek oil fields.

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