Plains CO_2 Reduction (PCOR) Partnership Monthly Update
January 1–31, 2016

PHASE III ACTIVITIES

Task 1 – Regional Characterization (Wesley D. Peck)

Highlights

- Participated in a January 6, 2016, conference call to discuss the ongoing development of the U.S. Department of Energy (DOE) Site Characterization best practices manual (BPM). The outline of a new chapter was discussed and next steps planned.
- 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: 64 new North Dakota wells and one new Montana well added.
    - Updated North Dakota production data.
    - Updated South Dakota, Nebraska, Wyoming, British Columbia, and Saskatchewan projects.
  - Continued database preventive maintenance of Petra projects.
- Working on a value-added carbon management plan for the state of North Dakota, which will incorporate data from the PCOR Partnership DSS on large point sources and potential sinks.
  - A suite of CO_2 emission reduction scenarios was developed that could reduce CO_2 from North Dakota's power plants by 45%, the state target under the U.S. Environmental Protection Agency (EPA) Clean Power Plan.
  - A team of engineers and scientists is using the Carnegie Mellon Integrated Environmental Control Model (IECM) to model individual units from North Dakota's coal-fired power plants. Baseline models were made. Options dictated by the emission reduction scenarios were modeled for each unit.
- With regard to the **Williston Basin** CO_2 Storage Sink Relative Permeability Laboratory Characterization:
  - Completed thin-section petrographic analyses.
  - Continued preparing the relative permeability system, including troubleshooting and repairing a leak in the system. The first sample from the Inyan Kara Formation was tested for CO_2 permeability at confining pressures of 4000 psi and 5600 psi.
  - Received Broom Creek mercury injection capillary pressure (MICP) data. It was turned into a series of charts for use in reporting.
  - Completed x-ray diffraction (XRD) analyses.

  - Resumed 3-D scanning for bulk volume on the Broom Creek samples.
  - Resumed porosity testing on the Broom Creek samples.
  - Continued quality checking steady-state gas permeability results.
  - Continued work on the value-added laboratory report.
- With regard to the **Aquistore** project's static modeling and dynamic predictive simulations effort:
  - Continue to process daily injection and pressure data. Rewrote the code to filter the noisy data properly and generate the simulation history match file simultaneously, which will be used for the simulation model.
  - Reran restart simulation with improved well performance. The simulation pressure is getting close to field data.
  - Ran the updated simulation.
  - Continued history-matching effort.
  - Held monthly internal meeting.
  - Prepared an abstract for internal review to be submitted for the Greenhouse Gas Control Technologies (GHGT)-13 Conference to be held November 14–18, 2016.
  - Began drafting Deliverable 93 (D93) – Geological Modeling and Simulation Report for the Aquistore Project.

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

Highlights

- Continued to apply changes based on final internal Energy & Environmental Research Center (EERC) review of the value-added update of the Phase II Lignite and Northwest McGregor fact sheets.
- Continued the value-added update of the Phase II Zama fact sheet. Worked on text and images. Reviewed text on pages 1 and 4 and began development of pages 2 and 3.
- Initiated efforts to update the Phase III fact sheet (D14) with efforts focused on determining the scope of the update, creating a time line, and making work assignments. Continued efforts by requesting content reviews from activity managers and reviewing the revised content. Completed the first draft of updated text.
- Initiated efforts to update the Outreach Action Plan (D11), with the focus on determining the time line and making work assignments. Continued efforts to update text, tables, figures, and appendices.
- Met to discuss the update of the Fort Nelson Feasibility Study fact sheet (D16). Discussion focused on working out a time line and assignments.
- Initiated efforts to update the Bell Creek Fact Sheet (D15) with a discussion of the format, preliminary time line, and work assignments.
- Continued review and revision of the DOE outreach BPM for the Regional Carbon Sequestration Program Outreach Working Group (OWG) based on the OWG conference call held December 17, 2015. A set of text comments were e-mailed to the BPM lead on January 13, 2016.
- Unable to take part in the OWG call on January 21, 2016, the Task 2 team provided comments by e-mail and followed up by e-mail with the OWG lead.

- Provided comments and updated a draft of an abstract on outreach to be submitted to the GHGT-13 Conference, in collaboration with PTRC, and discussed the abstract content by telephone on January 7, 2016.
- Notification of the North Dakota Department of Commerce Division of Community Services (DCS)-funded household energy and carbon footprint pages on the PCOR Partnership Web site was sent out with January electronic bills by the Grand Forks, North Dakota, city government.
- Reviewed and provided comments on a draft article intended for the EERC Solutions blog regarding the DCS-funded household energy and carbon footprint pages on the PCOR Partnership Web site.
- Compiled and entered outreach tracking data for the quarterly PCOR Partnership report.
- Continued efforts with regard to the public Web site (www.undeerc.org/pcor), including the following:
  - Reviewed additions and repairs to the Technical Poster page and prepared additional changes.
  - Prepared updated version of several PDF documents to include new URLs.
  - Worked on updating the PCOR Partnership Web site disclaimer.
  - Worked on Options to Reduce CO_2 page.
  - Continued ongoing identification and repair of broken links.
- Continued work on the Bell Creek (D21) documentary preproduction. Sent an e-mail to Denbury Resources Inc. (Denbury) regarding interview questions and possible dates for interviews at headquarters in Plano, Texas.
- Continued work on the coal documentary (D22), including reviewing draft script 1.0.
- Initiated discussions with the Dakota Science Center in Grand Forks, North Dakota, concerning the opportunity to have a sessions with 40 teacheers at the EERC in April 2016.

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

Highlights

- Continued working on the regulatory permitting document for the PCOR Partnership region (D76 – Regional Regulatory Perspective). The goal of this document is to help PCOR Partnership states through the permitting process. Continued compiling rules, regulations, and statutes crosswalks and flowcharts 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.
  - Prepared the Nebraska, Montana, Iowa, North Dakota, Minnesota, Wisconsin, Manitoba, and Saskatchewan injection well and underground injection control (UIC) permitting rules/regulations/statutes flowcharts and drilling regulatory crosswalks. Continued refinement and consolidation.
- Contacted a North Dakota Industrial Commission (NDIC) representative to discuss permitting questions.

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

Highlights

- **Bell Creek** test site activities included the following:
  - Continued work on the PCOR Partnership BPM D35 (Site Characterization), primarily modifying the outline.
  - Continued work on **modeling**, including the following:
    - Resumed work on the Bell Creek near-surface model and continue to make progress. Efforts are being concentrated in increasing the understanding of hydraulic head in the shallow subsurface of the field, shallow water chemistry, temperature and pressure conditions, etc. This model will be used to help understand the effect of CO_2 storage on the near-surface environment.
    - Worked on identifying which cells contain perforations in the Bell Creek Version 2 (Phases 3–7) model. This will assist with setting up the predictive simulation.
    - Continued work on improving the geomechanical models, both the 1-D and 3-D mechanical earth models (MEMs). The properties in these models were improved. Worked on preparing for the simulations.

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

- Continued update of the 2011 value-added CO_2 capture technologies overview document:
  - Of technologies included in the original document, 25 absorption technologies, 11 cryogenic/mineralization/reduction technologies, and the hydrogen membrane reactor technology were updated.
  - One membrane and seven adsorption technologies were found to require significant updating. It is expected that this will occur during February 2016.
  - Six of the technologies presented at the 2014 and 2015 DOE National Energy Technology Laboratory (NETL) capture technology meetings were readied for inclusion in the report.
  - One chemical absorption and one adsorption technology were found during Internet searches and are being readied for inclusion in the report.

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 in Quarter 4 – BP4, Year 8 (September 2015).

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

Highlights

- Completed and submitted the DOE CO_2 Storage Memo through December 2015. 2.753 million metric tons of CO_2 have been stored at Bell Creek.
- Submitted Milestone (M) 54 entitled "Bell Creek Test Site – Initial Processing and Analysis of Historic InSAR Data Completed." Received approval January 26, 2016.
- Continued work on the PCOR Partnership monitoring, verification, and accounting (MVA) BPM D51 (Monitoring for CO_2 Storage and CO_2 EOR). Modified and expanded the detail of the outline. Compiled a list of "lessons learned," which will serve as the basis for developing the BPM.
- Sent three abstracts for GHGT-13 to Denbury for review prior to submission. Titles include:
  - "Monitoring 2.5 Million Tonnes of CO_2 at the Bell Creek Oil Field"
  - "Impact of CO_2 Impurity on MMP [minimum miscibility pressure] and Oil Recovery Performance of Bell Creek Oil Field"
  - "4-D Seismic Monitoring Enhances Geological Interpretation, Reservoir Simulation, and Production Operations"
- Continued work on the life cycle analysis of oil produced during EOR compared with oil produced conventionally:
  - The stored CO_2 emissions were tracked to ensure that they are not double-counted in the spreadsheet model used by a consultant from The CETER Group (CETER).
  - Data about the gas-processing plants from which the CO_2 that is injected into the Bell Creek Field is sourced was researched. These data are needed by the GREET and CETER models.
  - Work continued on building the portions of the GREET model needed for it to represent CO_2 from a gas-processing facility producing natural gas and CO_2 rather than a coal-fired power plant.
  - A Webinar was held with NETL on January 28, 2016, to present the life cycle analysis work that has been conducted under the PCOR Partnership by a consultant with CETER. Several NETL personnel were in attendance, as well as a representative of the Bureau of Economic Geology (BEG).
  - Work continues on both the GREET model gas-processing plant module and the CETER Excel spreadsheet-based model.
- Held meetings with Denbury in Plano, Texas, on January 7, 2016. Agenda items included Bell Creek D21 documentary planning and scheduling of interviews, Bell Creek life cycle assessment, pulsed-neutron logging (PNL) planning, seismic processing and interpretation update (Denbury and EERC presentations) and planning a path forward, update on initial InSAR processing, and revised time line and path forward for outstanding PCOR Partnership products under Denbury review.
- Worked on finalizing the "miscible" phase data sets.
- Received InSAR dataset from TRE Canada; continued processing the Phase 1 data.
- Received processed PNL data collected during the fall 2015 enhanced PNL campaign from Schlumberger.
- Downloaded National Risk Assessment Partnership (NRAP) tool DREAM to evaluate using PCOR Partnership MVA data.
- **Bell Creek** injection-phase site activities included the following:

- Continued reservoir pressure monitoring of the 05-06 OW (observation well) from the permanent downhole monitoring (PDM) system using the casing-conveyed pressure–temperature gauges (PTGs):
  - Near-continuous operation since April 2012.
  - Received a quote for the repair of the fiber optic distributed temperature system (DTS) unit. This device measures the downhole pressure and temperature using the fiber optic cable in the monitoring well. A short occurred on the motherboard of the DTS unit on November 4, 2015, resulting in it being removed and sent in for repair. It is anticipated repairs will be completed by March 15, 2016.
- Continued dynamic reservoir pressure and multiphase fluid flow simulation efforts:
  - Consistent progress since April 2011.
  - Simulation has focused on the sensitivity of EOR performance to variations in the amount of impurities, mostly methane, in the injection recycle stream.
- Continued passive seismic monitoring of 04-03 OW using the borehole seismic array:
  - Near-continuous operation since May 22, 2013.
  - Sent a two-person crew to Bell Creek Field to repair network setting at the borehole array to restore ability to log in remotely. The array had gone idle about December 25, 2015. Tested remote connection and restarted array. The communications with the system were down, not the actual system. Communications downtimes are generally less than 8 hours.
  - Swapped recording to the new empty drive (Drive 3 was full) on the borehole array. Remotely assisted field team with array system swap and information.
  - Continued work on the 3-D seismic data interpretation and inversion process in Petrel and HR9.
  - Worked on putting culture files in Montana State Plane coordinates into the Hampson–Russell seismic software in order to improve our 4-D image. Culture files are phase boundaries, section and township lines, and more.
  - 4-D analysis of the 4-D VSP (vertical seismic profile) data is progressing. Horizon picking is in progress and difficult given the structural discontinuities.
- Used the most recent publicly available data to determine that cumulative total CO_2 gas injection is 3,848,446 metric tons through October 31, 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 98% CO_2 (Table 1). It should be noted that there were two injection wells that had cumulative data added to the Montana Board of Oil and Gas (MBOG) database during the October 2015 injection updates for this monthly reporting period; these cumulative totals consequently updated previous months' (March 2014 until current) totals.
- As of December 31, 2015, the most recent month of record, 2.807 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 2.753 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.

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

	October 2015 Injection
Total, Mscf	3,720,906
Total, U.S. tons[†]	121,830
Total, metric tons[†]	193,264
Cumulative Total, Mscf [‡]	74,094,137
Cumulative Total, U.S. tons[†‡]	4,238,068
Cumulative Total, metric tons[†‡]	3,848,446

Source: 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.

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

	December 2015 Gas Volume
Monthly Total Gas Purchased, MMscf[2]	1717
Monthly Total Gas Purchased, million tons[2]	0.098
Monthly Total Gas Purchased, million tonnes[2]	0.089
Cumulative Total Gas Purchased, MMscf[2,3]	54,034
Cumulative Total Gas Purchased, million tons[2,3]	3.091
Cumulative Total Gas Purchased, million tonnes[2,3]	2.807
Cumulative Total CO_2 Stored, MMscf[3,4]	53,003
Cumulative Total CO_2 Stored, million tons[3,4]	3.032
Cumulative Total CO_2 Stored, million tonnes[3,4]	2.753

[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.

- Developed talking points for discussions with Bell Creek landowners to provide guidance and information on how future outreach and engagement may be improved.
- Worked on landowner packages for all surface and near-surface MVA activities that occurred after August 2015.
- Continued injection-phase sampling work, including the following:
  - Traveled to Gillette, Wyoming, for purchase and recycle gas sample collection and scalable, automated, semipermanent seismic array (SASSA) project activities at the Bell Creek test site January 25–29, 2016.
- Initiated analysis of the purchase and recycle gas stream samples collected on January 25, 2016. Gas chromatography (GC) analyses and data processing of the January 2016 purchase and recycle streams samples are under way. A summary of all oil and CO_2 gas stream samples collected for analyses to date is provided in Table 3.

Table 3. Oil and CO_2 Gas Stream Sampling and Analyses

Stream(s)	Dates Sampled
Production: Oil and CO_2 Gas[1]	Sept 2014,[2] Nov/Dec 2014, Jan 2015,[3] March 2015, July 2015
Purchase/Recycle: CO_2 Gas[4]	May 2014,[5] June 2014, July 2014, Sept 2014, Oct 2014, April 2015, July 2015, Sept 2015, Jan 2016

[1] Wells 56-14R, 32-02, and 05-06 unless otherwise noted; [2] Wells 56-14R and 32-02 only; [3] Well 05-06 only; [4] Both purchase and recycle streams unless otherwise noted; [5] Purchase stream only.

- Completed laboratory GC confirmatory analysis data for the August 2015 soil gas sampling event (31 samples).
- Completed laboratory GC confirmatory analysis data for the November 2015 soil gas sampling event (17 samples).

Task 10 – Site Closure (John A. Hamling/Larry J. Pekot)

- This task is anticipated to be initiated in Quarter 3 – BP 5, Year 9 (April 2016).

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

- This task is anticipated to be initiated in Quarter 3 – BP5, Year 9 (April 2016).

Task 12 – Project Assessment (Loreal V. Heebink)

Highlights

- Nothing to note at this time.

Task 13 – Project Management (Charles D. Gorecki)

Highlights

- Prepared the PCOR Partnership budget period (BP) 5 continuation application, including providing BP4 accomplishments from Program Year 3 to present; proposing BP5 task activities and budget; revising the Gantt chart with deliverables, milestones, and time line; and revising the statement of project objectives (SOPO). Submitted the application to DOE on January 22, 2016.
- A list of deliverables with due dates in Year 9 Quarter 2 (January–March 2016) that were revised in the BP5 continuation application was submitted for approval. Approval was received January 26, 2016. The deliverables with the revised due dates include:
  - D22: Task 2 – Energy from Coal 60-minute Documentary (July 31, 2016)
  - D55: Task 11 – Bell Creek Test Site – Cost-Effective Long-Term Monitoring Strategies Report (September 30, 2016)
  - D69: Task 9 – Bell Creek Test Site – Best Practices Manual – Simulation Report (May 31, 2017)
- Submitted an abstract entitled "The Plains CO_2 Reduction Partnership: Developing Technologies for CCS Deployment in Central North America" for the 35th International Geological Congress to be held August 27 – September 4, 2016, in Cape Town, South Africa.

- Continued planning for the spring 2016 Technical Advisory Board (TAB) meeting to be held in New Orleans, Louisiana, on April 4–6, 2016.
- Continued planning the 2016 PCOR Partnership Annual Membership Meeting, including save-the-date cards, workshop ideas, and evening activities.
- Met to discuss PCOR Partnership Web site and DSS server hardware needs.
- Completed deliverables and milestones in January:
  - December monthly update
  - Task 9: M54 – Initial Processing and Analysis of Historic InSAR Data Completed
  - Task 13: D58/D59 – Quarterly Progress Report/Milestone Quarterly Report

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

Highlights

- Discussed progress of the *International Journal of Greenhouse Gas Control* (IJGGC) Special Issue paper reviews with a consultant from CETER.
- Completed second IJGGC Special Issue paper review.
- Contacted reviewers of IJGGC Special Issue papers. Contacted IJGGC representative to discuss schedule.
- An update of the IJGGC special issue was provided to the managers of the journal.
- Held the January WWG monthly conference call on January 27, 2016, to discuss progress of the IJGGC Special Issue and the DOE BPM sidebars, as well as the frequency of future conference calls and potential topics.
  - The IJGGC special issue articles are under review or have been reviewed. These will be returned to their authors soon.
  - Sidebars for the DOE BPMs have been drafted or are being drafted and will be distributed to the group next week for a brief review.
  - Future calls are likely to be less frequent. A February call may not be held.

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

- January 6–8, 2016: traveled to Plano, Texas, for project meetings with Denbury personnel.
- January 7–8, 2016: traveled to Gillette, Wyoming, for repairs to the borehole array network and the SASSA project trigger switch at the Bell Creek test site.
- January 25–29, 2016: Off-site staff member traveled to the EERC offices in Grand Forks, North Dakota, for meetings and work on state and provincial regulation flowcharts and crosswalk documents.

- January 25–29, 2016: traveled to Gillette, Wyoming, for purchase and recycle gas sample collection and SASSA project activities at the Bell Creek test site.

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